SCIENCE

JANUARY 4, 1952

VOLUME 115 NUMBER 2975

Contents

Photoconductive Cells for Detection of Infrared Radiation: *O. Simpson* and *G. B. B. M. Sutherland* 1

News and Notes

Arid Zone Research: *Richard L. Boke, J. Pérès,* and *H. G. Thornton* 4

Technical Papers

The Inhibition of the Development of Histamine Sensitivity in Mice Immunized with *Hemophilus pertussis*: *Elizabeth H. Thiele* and *Lee F. Schuchardt* 8

The Life Span of Leucocytes in the Human: *Daniel L. Kline* and *Eugene E. Clifton* 9

Significant Spatial Distribution Patterns of Minerals in the Coeur d'Alene District, Idaho: *Thomas W. Mitcham* 11

DDT Resistance in Korean Body Lice: *Herbert S. Hurlbut, Robert M. Altman,* and *Carlyle Nibley, Jr.* 11

Transition Energy Determination for Orbital Capture: *P. R. Bell, Josef M. Jauch,* and *Judith M. Cassidy* 12

Oxidative Dissimilation of Nonnitrogenous Compounds in *Acetobacter suboxydans*: *T. E. King* and *Vernon H. Cheldelin* 14

The Absorption of Human Skin between 430 and 1,010 mμ for Black-Body Radiation at Various Color Temperatures: *Raymond R. Heer, Jr.* 15

The Retention of a Discrimination: *J. A. Dinsmoor* 18

Effects of Indolebutyric Acid and Other Compounds on Virus Concentration in Plant Tissue Cultures: *R. Kutsky* 19

A New Method for Detecting Penicillinase Production by Staphylococci: *Abdel Aziz A. El Ghoroury* 20

The Decrease of Albumin Concentration of Human Blood Serum during Heat Inactivation: *Peter Koets* 21

Comments and Communications

Charles C. Davis and *Jacob Verduin* 22

Book Reviews 24

Scientific Book Register 24

AAAS General Officers—1952 3

Meetings & Conferences 16

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

the new *Lab-aid* way to store and view color transparencies

Assembly of Lab-aid Transparency Tray Cabinets, with the illuminator cabinet drawer pulled out. Use the table base, or stack them with your present Lab-aid Files.

You know how efficiently Technicon Lab-aid cabinets bring order to the filing of microslides, paraffin blocks and associated materials in the pathologic laboratory.

Now, in this new addition to the Lab-aid Filing System, you can enjoy the same benefits in the filing and viewing of color transparencies and lantern slides. The new Lab-aid transparency file has 40 smooth-sliding flat trays, each holding 16 standard 2" mounts, or 5 3¼" x 4¼" lantern slides in full view. They're easy to insert . . . you just drop them flat in the grooved frames. Easy to remove, too, by popping them out from underneath.

The special cabinet with its pull-out illuminator drawer lets you view a whole tray of transparencies at a glance, without removing any of them. Sitting or standing, you can inspect hundreds of slides under ideal viewing conditions without stirring from your place. And the disappearing shelf is a mighty handy place to lay slides down temporarily while you're working with them.

Both tray and illuminator cabinets are of the same dimensions and finish as all the other units in the Technicon Laboratory Filing System, and can be stacked interchangeably with them. If you would like more information about these or other units of the system, we'll be glad to send details.

The disappearing shelf is convenient as a temporary resting place for slides while working with them.

Inspect all your slides without removing any of them, or even stirring from your place.

Other units in the Lab-aid line

1" MICROSLIDE DRAWER FILES
2" SLIDE OR TRANSPARENCY DRAWER FILE
4" SLIDE OR INDEX DRAWER FILES
MICROSLIDE FLAT-FILING TRAY CABINET
PARAFFIN BLOCK FILE

technicon *Lab-aid* filing system

THE TECHNICON COMPANY
215 East 149th St., New York 51, N. Y.

WAR SURPLUS OPTICAL BARGAINS

35 POWER *ERECTING* MICROSCOPE

DESIGNED FOR GREATER UTILITY . . . VERSATILITY

AMAZING CLARITY • Gives you 3" of Working Space from Objective to Platform.

Swings To Any Position . . . Easily, Quickly!

A remarkable Instrument! Exceptional Value! Prism Erectors give you an erect image—exactly as your eye sees it, not upside-down as in an ordinary Microscope. Ramsden Eye-Piece permits fine precision focusing. 3-Element color corrected objective — 1" diameter. Microscope body is of brass with black crackle finish. Working distance from objective to object is almost 3", which permits any work, dissection, tooling, etc. to be carried on "under power" while looking through Microscope. The Instrument is 6½" long with base 7" x 9". Only because we were able to utilize some war surplus parts are we able to offer such a fine Optical Instrument—easily worth $75.00—at this special low price.

Stock No. 970-W ..... $29.50 Postpaid

DON'T MISS THIS BARGAIN • SATISFACTION GUARANTEED

LOOK AT THESE BARGAINS!

MOUNTED PROJECTION LENS—Speed F/1.9 . . . F.L. 15 mm. $22.00 value for $7.50. Low Reflection Coated. Used on 8 or 16 mm. Movie Projectors . . . or to make a Desk Viewer or Editor . . . for 16 mm. Micro-film Reader . . . for Contour Projector for very small items.
Stock #4045-W ..... $7.50 Postpaid

LENS CLEANING TISSUE—1st quality, sheet size 11" x 7½". Made to Gov't. spec. Free of abrasives. High wet strength.
Stock #721-W ..... 500 sheets ..... $1.00 Postpaid

SLIDE PROJECTOR SETS—Consist of all unmounted lenses you need to make the following size projectors:
Stock #4029-W—35 mm. ..... **$2.85 Postpaid**
Stock #4033-W ..... 2¼" x 2¼" ..... **$3.35 Postpaid**
Stock #4039-W ..... 2½" x 3½" ..... **$3.35 Postpaid**

LOOK! LOOK! LOOK!

Sheet Polarizing Material—
Stock #691-W ..... Pair of 1" dia. Circles ..... **20¢ Pstpd.**
Stock #692-W ..... Pair of 2" dia. Circles ..... **35¢ Pstpd.**

SO MUCH *for* SO LITTLE!

SIMPLE LENS KITS!—Kits include plainly written, illustrated booklet showing how you can build lots of optical items. Use these lenses in experimental optics, building **TELESCOPES**, low power Microscopes, etc.
Stock #5-W—10 lenses ..... **$1.00 Postpaid**
Stock #25-W—45 lenses ..... **$5.00 Postpaid**
Stock #10-W—80 lenses ..... **$10.00 Postpaid**

MOUNTED ANASTIGMAT LENS—Free booklet with your order: "How to Make Your Own Enlarger." Speed f/7.7, focal length approx. 127 mms. Suitable for pictures, negatives, positives up to 3½ x 4¼".
Stock No. 8004-W ..... $7.50 Postpaid

TERRIFIC BARGAIN! BUBBLE SEXTANT

BRAND NEW and with Automatic Electric Averaging Device and Illuminated Averaging Disc for nighttime use. Govt. cost $217. Though brand new, we have re-checked Bubble and Collimation and guarantee perfect working order. Price includes wooden Carrying Case. Full directions for use accompany each shipment.
Stock #933-W ..... $22.50 Postpaid

NON-ABSORBING BEAM-SPLITTING MIRROR — Latest development! Optically flat to ¼ wave length. Size: 1-15/16" x 2-15/16"—¼" thick. Reflects approximately 50% and transmits approximately 50%. No light is absorbed. Has a three-layered film which accomplishes non-absorption.
Stock #567-W ..... $5.00 Postpaid

New Product Department!

POCKET HEAT for Cold Weather!

HAND WARMER

Ideal for outdoorsmen! Keeps hands warm in coldest weather. Works by itself—no wires, no batteries. Magic heater element reacts with fuel, stays warm 24 hrs. at a time! Absolutely safe. Practical, proven!
Stock #98-W .... Only $2.49 Postpaid

RONCHI RULINGS—BLACK LINE GRATING

Plate glass with etched parallel black lines—space between the lines is same as thickness of the ruled line itself. Normally cost $4.00 to $5.00 per sq. inch.

1 in. x 1 in. Stock No.	Lines Per In.	Price	2 in. x 2 in. Stock No.	Lines Per In.	Price
2122-W	65	$ .75	2133-W	65	$1.50
2126-W	85	.75	2134-W	85	1.50
2127-W	110	1.00	2136-W	110	2.00
2128-W	120	1.00	2137-W	120	2.00
2129-W	133	1.00	2138-W	133	2.00
2130-W	150	1.00	2139-W	150	2.00
2131-W	175	1.00	2140-W	175	2.00

All above sent Postpaid.

8 Power ELBOW Telescope
OUR PRICE $27.50

Big 2" diameter objective. All lenses Achromatic. Amici prism erects the image. 4 built-in filters—clear, amber, neutral and red. Slightly used condition but all guaranteed for perfect working order. Weight 5 lbs.
Stock #943-W $27.50 Pstpd.

BUBBLE SEXTANT—TYPE A-8A. Excellent condition but may be slightly used. Each has been carefuly checked and collimated. Averaging device for nighttime use. Carrying Case and instruction booklet included. Gov't cost about $325.00 **Stock #946-W ..... $32.50 Postpaid**

TELESCOPE EYE-PIECE—Consists of 2 Achromatic lenses F.L. 28 mm. in a metal mount.
Stock #5140-W ..... $4.50 Postpaid

IF YOU'RE INTERESTED IN OPTICAL BARGAINS
Write for FREE CATALOG W We Have Literally Millions of War Surplus Lenses and Prisms for Sale at Bargain Prices. Numerous Types of Instruments Too!

ORDER BY STOCK NO. Send Check or M.O. Satisfaction Guaranteed

EDMUND SCIENTIFIC CORP., BARRINGTON, N. J.

APPROVED FOR *Your* LABORATORY

CENCO

Cenco High Vacuum Pumps are renowned for high speed evacuation and performance. Write for 48-page technical Bulletin 10 "High Vacuum Apparatus."

These tested and approved Cenco products assure efficient control in your laboratory. The **Cenco Tensiometer** serves reliably for the measurement of surface and interfacial tensions. Completely described in Bulletin 102 "Surface Phenomena." **The Cenco Cyclindrical Oven** provides dependable temperature control to 210°. Write for Bulletin 5 "Constant Temperature Equipment."

The **Cenco Electroanalyzer** saves time in the quantitative electroanalysis of metals. Ask for Circular 1200.

Cenco News Chats, a quarterly magazine published for laboratory workers in industry, education and research will be sent on request. Professional people are invited to send in their names for future editions.

CENTRAL SCIENTIFIC COMPANY

Scientific Instruments • Laboratory Supplies

1700 Irving Park Road, Chicago 13

CHICAGO NEW YORK NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER

Gladys M. Keener
Executive Editor

AAAS EDITORIAL BOARD
(Terms Expire June 30, 1952)

Howard A. Meyerhoff, **Chairman**
William R. Amberson Karl Lark-Horovitz
Bentley Glass Lorin J. Mullins

F. A. Moulton, Advertising Representative

AAAS General Officers–1952

THE Association's official year ends January 14, and on January 15 the officers elected at Philadelphia assume their responsibilities for 1952. Ten days hence Roger Adams retires from office. With a break of only two years he has served on the Executive Committee since 1940, becoming President-elect in 1949. Although eligible for re-election to membership in the Executive Committee, he declined nomination, and senior member of the committee in length of service (elected 1943), and its chairman ex officio, will be Kirtley F. Mather, Retiring President.

Of the general officers elected by the Council at Philadelphia last week, Conway Zirkle was chosen to serve a second term as Vice President and Chairman of the Section on the History and Philosophy of Science, and John R. Dunning was re-elected to membership in the Executive Committee. The complete roster of general officers for 1952 follows:

President: Detlev W. Bronk, The Johns Hopkins University.

President-elect: E. U. Condon, Corning Glass Works.

Retiring President: Kirtley F. Mather, Harvard University.

Vice Presidents and Chairmen of Sections:

Mathematics (A): Lawrence M. Graves, University of Chicago.

Physics (B): Edward O. Hulburt, Naval Research Laboratory.

Chemistry (C): Carroll A. Hochwalt, Monsanto Chemical Company.

Astronomy (D): Charlotte M. Sitterly, National Bureau of Standards.

Geology and Geography (E): A. C. Trowbridge, University of Iowa.

Zoological Sciences (F): Waldo L. Schmitt, U. S. National Museum.

Botanical Sciences (G): Lincoln Constance, Stanford University.

Anthropology (H): F. H. H. Roberts, Jr., Smithsonian Institution.

Psychology (I): Harold Schlosberg, Brown University.

Social and Economic Sciences (K): Howard R. Tolley, Washington, D. C.

History and Philosophy of Science (L): Conway Zirkle, University of Pennsylvania.

Engineering (M): Clarence E. Davies, ASME.

Medical Sciences (N): William S. McCann, University of Rochester.

Agriculture (O): Charles E. Kellogg, U. S. Bureau of Plant Industry.

Industrial Science (P): H. G. Batcheller, Allegheny Ludlum Steel Corporation.

Education (Q): J. Cayce Morrison, State Education Department, Albany, N. Y.

Members of the Executive Committee

Kirtley F. Mather (*Chairman*), Harvard University.
E. U. Condon, Corning Glass Works (1952–1954).
Detlev W. Bronk, The Johns Hopkins University (1951–1953)
John R. Dunning, Columbia University (1952–1955).
Walter S. Hunter, Brown University (1951–1954).
Mark Ingraham (1952).
Paul E. Klopsteg, National Science Foundation (1949–1952).
Howard A. Meyerhoff, AAAS (1949–1952).
Fernandus Payne, Indiana University (1950–1953).
Paul B. Sears, Oberlin College (1951–1954).
Laurence Snyder (1952–1955).
Warren Weaver, Rockefeller Foundation (1950–1953).

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

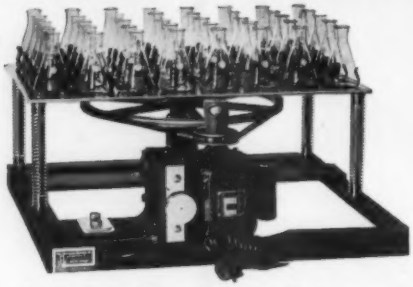
All correspondence should be sent to SCIENCE, 1515 Massachusetts Ave., N.W., Washington 5, D. C. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. Four weeks' notice is required for change of address, and an address stencil label from a recent issue must be furnished. Claims for a missing number will be allowed only if received within 60 days from date of issue.

Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Special rates to members of the AAAS.

The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates on request.

Rotary Action

FLASK SHAKER



- Smooth operating, non-creeping and vibration free.
- Variable speed control . . . 160 to 400 oscillations per minute.
- Precision built for continuous operation.
- Versatile for experimentation, research or production.

PRICE $379.30 · · · F O B NEW BRUNSWICK, N. J.

Detailed information available upon request.

NEW BRUNSWICK SCIENTIFIC CO.

PRECISION LABORATORY APPARATUS

10 HIRAM STREET • NEW BRUNSWICK, N. J.

Now available . . .

Adenosine Triphosphate (ATP); Amygdalin; Amylase; Animal Lecithin; Ascorbic Acid Oxidase; Bacitracin; BAL; Biotin cryst.; Caffeic Acid; Carotene cryst.; Catalase; Cellulase; Chlorogenic Acid; Chorionic Gonadotropin; Circulatory Hormone; Colchicine; Cytidylic Acid; Cytochrome C; Dehydroascorbic Acid; Dihydroxyacetone; Dihydroxyphenylalanine (DOPA); Dipyridyl; Edestin; Emulsin; Erythritol; N-Ethylpiperidine; Fibroin; Folic Acid; Galacturonic Acid; Gentisic Acid; Girard Reagents P and T; Gliadin; Glucose Pentaacetate; Glucuronic Acid; Glyceraldehyde; Glyceric Acid; Heparin; Hordenine; Hyaluronidase; 2-Hydroxyadipaldehyde; Humulon; Isoascorbic Acid; Isopropylarterenol; Kojic Acid; Kynurenic Acid; Lanthionine; Lipase; Lysozyme; Lyxose; Malononitrile; Maltase; Melezitose; Mesobilirubinogen; Muscle Adenylic Acid; Myanesin; p-Nitrophenylphosphate; Nucleoprotein; Orcinol; Pancreatin; Pangestin; Pantothenyl Alcohol; Penicillinase; Peroxidase; Phenazine; Phenylpyruvic Acid; Phloridzin; Phosphorylase; Piperin; Porphyrindene; Protamines; Pyridoxal; Pyridoxamine; Pyrocatechuic Acid; Pyruvic Aldehyde; Ribonuclease; Saccharic Acid; Salmine; Serine Phosphoric Acid; Spermidine; Spermine; Thioacetic Acid; Thiocytosine; Thyroxine; Trigonellin; Triphenyltetrazolium Chloride; Tripyridyl; Trypsinogen; Tyrosinase; Tyrothricin; Urease; Uricase; Uridine; Vitellin; Xanthosine.

Ask us for others!

DELTA CHEMICAL WORKS

23 West 60th St. New York 23, N. Y.

Telephone Plaza 7-6317

THE CSI HIGH SPEED ANGLE CENTRIFUGE

CS-26

- 20,000 RCF x g
- Two styles interchangeable rotors for maximum flexibility.
- Self-balancing precision rotors machined from special hand-forged duralumin alloy.
- Modern design unit housing with integral control panel and guard. Fully corrosion resistant.
- Tube angle 32°.
- Speed control fully adjustable.
- Low in first cost.
- Low in maintenance cost.

FOR INFORMATION WRITE DEPT. "S"

CSI

CUSTOM SCIENTIFIC INSTRUMENTS, INC.

Post Office Box 170 Arlington, N. J.

MANUFACTURERS OF CUSTOM-BUILT LABORATORY EQUIPMENT

CSI

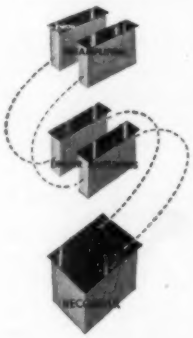
REAL RECORDING VERSATILITY

Your choice of 1-, 2-, or 4- channel systems — each with all the advantages that the famous name "Sanborn Viso" denotes

VISO-CARDIETTE

While designed primarily as a direct-writing clinical electrocardiograph that can quickly record *all* accepted leads, this oldest member of the "Viso family" will also register *many other* phenomena, using suitable supplementary equipment. Its proven recording principles provide the basis for the design of the 1-, 2-, and 4-channel systems below. These instruments feature standard "Viso" advantages: immediately visible, permanent records traced by heated stylus (no ink) on plastic coated, continuous chart paper; recording in *true* rectangular coordinates; *independent* timing; and simplified control. The recording paper speed of Viso-Cardiette is 25 mm/sec. Paper width is 6 cm with a 5 cm recording area.

INTERCHANGEABILITY of Preamplifiers and Amplifiers permits recording of many different types of phenomena.



Any of the recording channels in the three systems at the right may include *either* a Strain Gage or General Purpose Amplifier, or the latter in combination (in 2-, and 4-channel systems) with either AC or DC Preamplifiers. For, any of the Amplifiers or Preamplifiers provided for in a system may be quickly *removed* from its place in the system and as quickly *replaced* with an alternate type.

VISO RECORDER (SINGLE CHANNEL)

A simple and *lower cost* means of securing all the recording advantages of the Viso-Cardiette (described above), when electrocardiography is not a requirement, is offered in this assembly. The system comprises a single-channel recording unit, patterned closely after that of the Viso-Cardiette, and assembled in one case with *either* a General Purpose or Strain Gage Amplifier which are *interchangeable* as described at the left.

TWIN-VISO CARDIETTE (TWO-CHANNEL)

The two channels of the Twin-Viso operate independently of each other, but register simultaneously on one Permapaper record. Or, one channel may be used alone, with 1-channel recording Permapaper. A standard, "built-in" feature of the Twin-Viso is a choice of *ten* paper speeds which may be selected at will by the operator thru a quick and simple interchanging of sets of gears. These speeds are in pairs of 5 and 0.5, 10 and 1, 25 and 2.5, 50 and 5, and 100 and 10 mm/sec. Either speed of any pair selectable at will by panel control. Standard "Viso" recording advantages (described above) are inherent in the Twin-Viso and the Poly-Viso Cardiettes, and to them is added manually or remotely controlled code marking.

POLY-VISO CARDIETTE (FOUR-CHANNEL)

This multi-channel research recorder provides for one-, two-, three-, or four-channel registrations on one record, using Permapaper of appropriate widths. The Poly-Viso operates under the same principles as the Viso- and Twin-Viso Cardiettes described above and offers a "built-in" choice of eight paper speeds: 50, 25, 10, 5, 2.5, 1.0, 0.5, and 0.25 mm/sec., *all* selectable by panel control.

RECORDERS AND AMPLIFIERS ARE AVAILABLE SEPARATELY

The Recorders, Amplifiers and Preamplifiers of which the above complete systems are comprised may be obtained *separately*, to be combined or integrated by the user with other equipment.

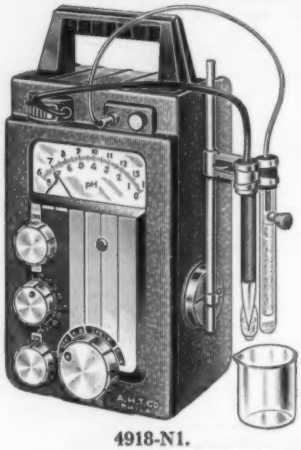
For descriptive literature or information of any kind about this equipment, address

SANBORN CO. CAMBRIDGE 39 MASSACHUSETTS

NEW

BECKMAN MODEL N pH METER

PORTABLE - BATTERY OPERATED - RUGGED



4918-N1.

ADVANTAGES

Model N offers all the advantages of former Model M, which it replaces, and, in addition:

Subminiature electronic tubes (3), powered by hearing aid and flashlight batteries,

Built-in temperature compensation, 0 to 100° C,

Light weight aluminum case (weight 7½ lbs.), sealed and desiccated, with attached handle; convenient for laboratory, plant or field use, and

Rapid warm-up, permitting the instrument to be turned off between measurements, thereby saving battery life.

BECKMAN MODEL N GLASS ELECTRODE pH METER, Battery Operated. A compact, direct reading instrument which uses the same basic circuit as Model M, which it replaces. With double, overlapping pH scale approximately 4 inches long reading in 0.1 pH division from pH 0 to 8 in red figures and from pH 6 to 14 in black; built-in temperature compensation 0 to 100° C; and control panel provided with "standardization" and "check" control knobs, switch for selection of range and "off," and humidity indicator.

Can be used in either vertical or horizontal position. Warm-up is rapid—approximately 10 seconds—permitting the instrument to be turned off between measurements, thereby saving battery life.

Furnished with sturdy 5-inch general purpose glass electrode and companion calomel electrode. Readings can be made rapidly with an accuracy of 0.1 pH over the range to pH 11, but greater accuracy is possible with careful operating technique. For use in the range pH 9 to 14, Type E glass electrode, with low sodium ion error, is recommended.

The various types of electrodes offered for use with Models M and H-2, including our 4923-F5 Electrode Conversion Assembly for volumes of only 2 to 3 ml, can all be used with Model N. Continuous readings can be made, and the instrument is convenient for making rapid acid-alkali titrations.

4918-N1. Glass Electrode pH Meter, Beckman Model N-1, complete with 5-inch glass and calomel electrodes, electrode holder, 50 ml Pyrex brand glass beaker, 1 pt. Buffer Mixture pH 7.0, 100 ml bottle saturated KCl solution, in case with handle **180.00**

4918-N2. Ditto, but with hinged double case providing carrying space for accessories required for field use **195.00**

More detailed information sent upon request.

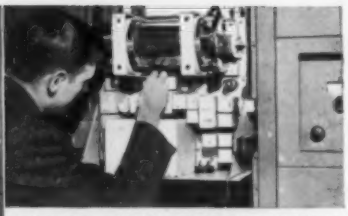
ARTHUR H. THOMAS COMPANY

RETAIL—WHOLESALE—EXPORT

LABORATORY APPARATUS AND REAGENTS

WEST WASHINGTON SQUARE **PHILADELPHIA 5, PA., U. S. A.**

Cable Address, "BALANCE," Philadelphia



Each crystal is enclosed in a cylindrical oven which holds the crystal temperature to within 1/100 of a degree.

At the A. T. & T. building at 195 Broadway, New York, passersby set watches by the world's most accurate public clock, which is controlled by the master standard.

Front of the new frequency-time standard at Bell Telephone Laboratories. In the rear there are 600 electron tubes and 25,000 soldered connections. Room temperature is maintained within two degrees.

A vibrating crystal keeps master time

The controlling quartz crystal vibrates in vacuum at 100,000 cycles per second. The standard is powered by storage batteries, with steam turbo-generator standing by, just in case of emergency.

Ever since Galileo watched a lamp swinging in Pisa Cathedral, steady vibration has measured time. In the 1920s Bell Laboratories physicists proved that quartz crystal oscillators they developed to control electrical vibration frequency in the telephone system paced out time more accurately than ever.

Bell's latest master standard keeps an electric current vibrating at a frequency that varies only one part in a billion, keeping time to one ten-thousandth second a day.

A master oscillator governs carrier frequencies of the Bell ship-to-shore, overseas and mobile radiotelephone services, the coaxial and *Radio-Relay* systems which carry hundreds of simultaneous conversations, or television. In northeastern states, it helps keep electric clocks on time.

The new standard also provides an independent reference for time measurements made by the U. S. Naval Observatory and the National Bureau of Standards. Thus, world science benefits from a Laboratories development originally aimed at producing more and better telephone service.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

Technical Associates Expands Its

ISOTOPE DEPARTMENT

Our Isotope Department offers tagged compounds and radiation sources, for use in medical, industrial, and basic research applications.

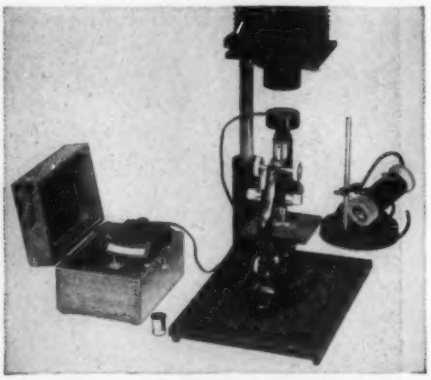
HEALTH PROTECTION SERVICE

Technical Associates offers a new Film Badge Service, with choice of badge, wrist, or finger film. Also available is a complete air monitoring service. Prices on request.

Inquiries Invited

TECHNICAL ASSOCIATES
140 West Providencia Ave., Burbank, Calif.

PHOTOVOLT
Exposure Photometer Mod. 200-M
for
PHOTOMICROGRAPHY



Accurate determination of exposure time in black-and-white and color photomicrography

Write for Bulletin #810 to Price $65.—

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

A READY REFERENCE
That Will Save Time for You

Use this catalog as a "one stop" source of supplies required in biological and microbiological research.

It lists Amino Acids, Vitamins, Carbohydrates, Adenylates, Nucleates, Purines, Pyrimidines, Tetrazolium Salts, Enzymes, Microbiological and Bacteriological Media, Complete Animal Test Diets and Ingredients, and a wide range of Biochemicals for Investigational Use.

Write for Your Copy TODAY

GBI **GENERAL BIOCHEMICALS, INC.**
60 LABORATORY PARK • CHAGRIN FALLS, OHIO

LABORATORY OVENS

Several sizes in both forced-convection and gravity-convection types. For temperatures to 260° C. and constancies as close as ±0.5° C.

Bulletin 2159-K

LABORATORY BATHS

Refrigerated and non-refrigerated baths of various types for a wide range of operating temperatures and extremely close constancies.

Catalog 48-K

YOU GET *IMPORTANT* EXTRAS WHEN YOU BUY AMINCO Constant Temperature Equipment

AMINCO engineers are old hands at making good products better. That's why you find extra quality in every detail of Aminco equipment. Finest quality materials, experienced engineering, painstaking production and testing are combined to give you the most for your money in quality, performance and service life. Compare and you will agree that there is no substitute for Aminco's 30 years of experience.

BACTERIOLOGICAL INCUBATORS

Small-capacity and large-capacity bacteriological incubators covering a range of from 0°C. to 60°C. Constancy as close as ±0.15°C. Many important features.

Bulletin 2159-K

SUB-ZERO TEST CABINETS

Provide low-cost, accurate, and reliable refrigeration for testing, conditioning, and storage operations. Temp. range, −120°F. to +220°F. Dry-ice cooled.

Bulletin 2133-K

Ask for literature of other constant temperature products including heaters, thermoregulators, stirrers, relays, etc.

Since 1919 AMINCO

AMERICAN INSTRUMENT CO., INC. SILVER SPRING, MD.

Don't Suffer from "FOCUS-FATIGUE"!

Enjoy QUICKER, EASIER FOCUSING than ever before . . .

with

BAUSCH & LOMB

Dynoptic

LABORATORY MICROSCOPES

Convenient hand-height control knobs permit relaxed operation, assure comfort, for more thorough examinations over prolonged periods. Ball and roller bearings, used throughout the focusing system, provide smooth balanced motion, reduce friction and wear to a negligible minimum. No binding! No backlash! Enjoy these and many more *exclusive* advantages of the *world's finest laboratory microscopes.*

Write for **FREE DEMONSTRATION and LITERATURE.**
See for yourself how Bausch & Lomb *Dynoptic* Microscopes outperform any laboratory microscope ever made. Bausch & Lomb Optical Co., 642-19 St. Paul St., Rochester 2, N. Y.

Photoconductive Cells for Detection of Infrared Radiation

O. Simpson and G. B. B. M. Sutherland

Department of Physics, University of Michigan, Ann Arbor

WITHIN THE PAST FIVE YEARS photoconductive cells have become available for the detection of infrared radiation in the range between 1.5 μ and about 5.5 μ. These were developed or partially developed for military purposes in the years 1939–45 but are now finding many valuable and interesting applications of a purely scientific and industrial nature. It is the purpose of this article to review briefly some of their applications and published information concerning the performance of such detectors so that those unfamiliar with them may be able to estimate their capabilities for other applications. We shall not consider detectors that have a long wave limit of detection below 1.5 μ, since there are a great many photodetectors of this type, the most generally useful photoconductor in this range being the thallium sulfide ("Thalofide") cell with a limit at about 1.2 μ.

Among the materials that are photoconductive beyond 1.5 μ there are three that have been intensively studied and shown to have useful properties as infrared detectors; these are lead sulfide, lead selenide, and lead telluride. It is necessary to have such a material in the form of a thin layer (10^{-4} to 10^{-5} cm) deposited either by evaporation or by chemical means on a nonconductor (generally glass); in most cases, some oxygen is deliberately introduced into the layer. The dark resistance of such a layer may be between 10^4 and 10^8 ohms, and the response time between 10^{-3} and 10^{-5} seconds.

In Table 1 we have attempted to summarize the essential features of these three types of cell which can be prepared in several ways and operated under various conditions. Methods of preparation have been described for (*a*) lead sulfide by Sosnowski, Starkiewicz, and Simpson (*1*), Kicinski (*2*), and Cashman (*3*); (*b*) lead selenide by Blackwell, Simpson, and Sutherland (*4*) and Milner and Watts (*5*); (*c*) lead telluride by Simpson and Sutherland (*6*). Lead sulfide layers can be made which are excellent photoconductors at room temperature, even when exposed to the atmosphere. The better layers usually have to be kept *in vacuo*, and a considerable improvement is usually obtained in the responsivity by cooling the layer to the temperature of solid CO_2. Further cooling to the temperature of liquid air and liquid hydrogen enhances this effect somewhat and also causes the long wave limit of sensitivity to move from 3.3 μ to about 3.6 μ (*7*). However, since the resistance of the layer increases very rapidly as the temperature is lowered, and the time of response is markedly increased, it is not always advantageous to work with a cooled cell. On the other hand, selenide and telluride cells do not show a usable photoconductivity unless cooled to at

TABLE 1

	Lead sulfide	Lead selenide	Lead telluride
Special range	Visible to 3.0 μ	Visible to 4.5 μ	Visible to 5.5 μ
Method of preparation	Evaporation or chemical precipitation	Evaporation or chemical precipitation	Evaporation
Operating conditions	1) Room temperature open to atmosphere 2) Room temperature *in vacuo*		
	3) Low temperature (−78° C to −190° C) *in vacuo*	Low temperature (−190° C) *in vacuo*	Low temperature (−190° C) *in vacuo*
Availability	British Thompson Houston Company, Rugby, Eng. (*1–3*) Photomho Chicago, Ill. (*2*) Continental Electric Chicago, Ill. (*2*) Eastman Kodak Rochester, N. Y. (*1–3*)	Not commercially available	Not commercially available
Response time	1) 4×10^{-3} sec at 20° C 2) $4–10 \times 10^{-3}$ sec at 20° C 3) $2–7 \times 10^{-4}$ sec at −190° C	$3–10 \times 10^{-3}$ sec at −190° C	$1–5 \times 10^{-4}$ sec at −190° C

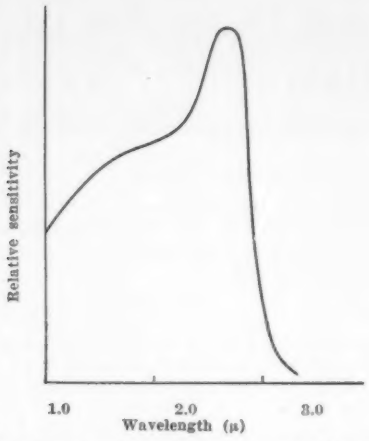


FIG. 1. The spectral sensitivity of a lead sulfide cell.

least −78° C, and in practice they must be operated at liquid nitrogen temperatures.

At present only lead sulfide cells are commercially available. All three types have a nonuniform response with respect to the various wavelengths to which they are sensitive. A typical curve of responsivity as a function of wavelength is shown for lead sulfide in Fig. 1. In lead selenide the maximum is between 3 μ and 4 μ, and for lead telluride it is a little beyond 4 μ. However, the responsivity curves are very sensitive to the method of preparation, and the positions and widths of the maxima vary considerably. The lead sulfide cells that are operable at room temperature are generally peaked closer to 2 μ than 3 μ.

Additional information about the characteristics of these cells (e.g., frequency response and dependence of noise on frequency) can be found in review articles by Elliott (*8*), Sutherland and Lee (*9*), and Smith (*10*). In this article we shall discuss principally the performance of these cells as radiation detectors and in particular review the question of how closely they approach the theoretical limit of being "perfect" detectors.

Whenever a radiation detector has to be chosen for a particular purpose, it is necessary to compare the performance of all available types before selecting the one that is likely to give the best results under the proposed experimental conditions. There is, however, no simple "figure of merit" for the comparison of detectors that will be valid for all possible applications. For example, the detector in a spectrometer designed for high resolution work must have primarily a very low noise equivalent power, whereas the detector in a spectrometer designed for oscillograph presentation of spectra must have, primarily, a very short time of response. In order to estimate the performance of a photoconductive detector under arbitrary operating conditions, it is therefore necessary to specify two quantities—(*a*) the responsivity, defined as the output in microvolts per microwatt incident power, as a function of frequency, exciting current in the detector, temperature of the detector, and wavelength of the incident radiation; (*b*) the noise power per unit band width as a function of the same variables. Unfortunately such extensive data are rarely available, and it is the common practice to define a single parameter, or figure of merit, for the purpose of comparison under some specified operating conditions. Daly and Sutherland (*11*) have considered a figure of merit for a detector used in the cathode-ray presentation of infrared spectra. They chose as a criterion the energy in a pulse signal that will be just detectable above noise, the over-all band width of the amplifier-display system being adjusted to a value appropriate to the optimum radiation pulse length. They show that the minimum pulse energy is proportional to $(\mu\tau^{1/2}/\sigma)$, where τ is the time constant of the detector (assumed to have a simple exponential response), μ is the mean square noise voltage per unit band width originating in the detector, and σ is the zero-frequency responsivity. From the data then available they concluded that under this criterion, and working at the optimum wavelength, lead sulfide and lead telluride detectors are between 10 and 100 times better than superconducting bolometers, and these in turn are about 100 times better than Schwartz-type thermocouples.

Apart from the question of the actual sensitivities of existing detectors, the theoretical ultimate sensitivity of a particular type of detector is of interest in showing how far below the ideal any given detector may be. The limiting sensitivity is determined by the responsivity to radiation and by the noise in the detector. The mean square noise, or noise power, is the sum of contributions from all sources, including Johnson noise and noise due to fluctuations in both the exciting current and in the incident radiation flux (*12, 13*). In the normal method of operation of a detector, the exchange of radiation between the sensitive element and its surroundings greatly exceeds the incident signal radiation. When all other sources of noise are negligible, fluctuations in the background radiation will impose a theoretical limit on the smallness of a detectable signal, beyond which no improvement is possible. Jones (*14*) has discussed this source of noise as the cause of the ultimate limit of sensitivity in a number of different detectors, and Fellgett (*15*) has extended Jones' method to apply to photoconductive lead sulfide and lead telluride detectors. Fellgett calculated the limiting sensitivity, imposed by radiation fluctuation, for a lead sulfide and a lead telluride cell from their measured responsivity-wavelength characteristics. The assumption was made that the cells were cooled, but exposed to a solid angle 2π of radiation from surroundings at 15° C. Under these conditions the ultimate sensitivity of the lead sulfide detector was calculated as 2.1×10^{-13} watt at the optimum wavelength, compared with the measured noise equivalent power 4.9×10^{-13} watt. Both figures referred to unit band width. The corresponding figures for the lead telluride detector were 2.3×10^{-13} and

4.4×10^{-13} watt. These results show that the total noise in the detectors was only about twice as great as that due to radiation fluctuations alone. Simpson (*16*) has shown that the conductivity of a lead telluride photoconductor at $-190°$ C is increased 10 to 100 times by exposure to background radiation from surroundings at room temperature. Under the conditions prescribed by Fellgett, therefore, almost the entire current in the detector appears to be photocurrent. It is thus not surprising that the noise should arise primarily from fluctuations in the incident flux.

Moss (*17*) has discussed the same question, and in particular has investigated the dependence of the ultimate sensitivity, for various signal wavelengths, on the shape of the spectral responsivity curve. Since in the case of photoconductive detectors the majority of the background radiation is normally of greater wavelength than the wavelength for maximal responsivity, it is disadvantageous for a detector to have appreciable photosensitivity at wavelengths greater than that of the signal. Sensitivity in the long wavelength tail of the spectral response curve adds appreciably to the radiation noise. Calculations by Moss show that the limiting sensitivity for a lead sulfide cell at 2.3 μ deteriorated from 5.2×10^{-14} watt at 273° K to 17×10^{-14} watt at 90° K because of the change in spectral response on cooling, the responsivity at long wavelengths being preferentially increased at low temperatures. On the other hand the limiting sensitivity at 3.5 μ for the same detector improved from 2×10^{-11} watt at 273° K to 15×10^{-14} watt at 90° K. Values quoted by Moss for the limiting sensitivity of lead telluride are of the order of 10^{-13} watt at optimum signal wavelength. There is a good measure of agreement between Fellgett's results and those of Moss. Such differences as there are should probably be attributed to differences in the characteristics of the individual detectors with which they worked.

The theoretical limit of sensitivity imposed by radiation fluctuations is, in fact, only a relative limit introduced by the assumption that a detector is always exposed to a background of room temperature radiation. Clearly, if the background radiation is a substantial source of noise, improvement may be gained by minimizing background radiation. Ideally, therefore, a detector should be used at its optimum temperature in an enclosure with walls at this same temperature. In the case of lead sulfide or lead telluride operated at liquid air temperature, the radiation field would be reduced to that of a black body at $-190°$ C, instead of 20° C, with a consequent large reduction of radiation fluctuations. Unfortunately this precaution introduces practical difficulties, because it is necessary to provide some aperture in the enclosure to admit the signal radiation. There are so far no experimental data concerning the performance of photoconductive detectors with adequate shielding, but it is reasonable to suppose that some improvement in sensitivity would be gained by cutting down the background radiation, at least to such a level that Johnson and current noise become the principal sources of detector noise. In the case of a spectroscopic application, the ideal situation would be to admit the signal radiation through a *cooled* filter. If the band pass of the filter were sufficiently narrow, the background radiation entering the detector enclosure could presumably be reduced to an arbitrarily low level. The question of the ultimate sensitivity imposed by sources of noise other than radiation background awaits further investigation of the properties of lead sulfide and lead telluride. At present it is not possible to prescribe the optimum resistance, exciting current, or temperature for any photoconductive material. However, some progress in this direction has been made by Simpson and Sutherland (*6*), who have shown that there is a quantitative correlation between responsivity and resistance of lead telluride. This resistance is, in turn, dependent on the stoichiometric excess of lead in the photoconductive material. Moss (*7*) has correlated the spectral response with temperature for lead sulfide and lead telluride, and there is some evidence (*18*) concerning the correlation of responsivity with oxygen content of the materials.

The most interesting applications of these new detectors in pure scientific research have been in the field of infrared spectroscopy, where advances have been made in resolving power, in scanning speed, and in the observation of spectra of extraterrestrial objects. Until such sensitive detectors were available, the resolving power of an infrared spectrometer was always limited by the sensitivity of the detector and not by optical considerations. With a lead sulfide cell, Sutherland, Blackwell, and Fellgett (*19*) achieved a resolving power of over 30,000 in the water vapor spectrum near 2.5 μ. The closest pair of lines previously resolved in this region with a thermocouple detector had a separation of 0.6 cm^{-1}, corresponding to a resolving power of 7,000. More recently a lead sulfide cell has been used by the McMath Hulbert Observatory of the University of Michigan (*20*) in making a definitive map of the atmospheric absorption spectrum between 0.85 μ and 2.5 μ, in which resolving powers of over 50,000 have been achieved at various points in this range. It appears probable, therefore, that the optical limit will soon be reached, and indications that this is so are becoming evident in current work by the same group in collaboration with Mount Wilson Observatory.

It is often very desirable to be able to follow rapid changes in infrared spectra, such as occur in an explosion or in the early stages of a rapid chemical reaction. With a fast bolometer, the scanning time for a range of a few microns is of the order of several seconds (*21*), if resolving power is not to be unduly sacrificed. However, Bullock and Silverman (*22*) have shown that, by using lead sulfide, selenide, and telluride cells, it is possible to scan a range of 2 μ between 1 μ and 5 μ in a time of the order of a few thousands of a second, with a resolving power of about 100 near 3 μ, and in this way they have been able to study the initial stages of the explosive reaction between oxygen and carbon dioxide. More re-

cently Daly (*23*) has developed a similar rapid-scanning spectrometer that allows very accurate measurement to be made of the percentage absorption by using a double beam technique, which eliminates effects of atmospheric and solvent absorption.

The use of infrared spectroscopy to study the atmospheres of the planets has already given a wealth of information about the presence of carbon dioxide, ammonia, and methane on several planets (*24*). The use of photoconductive detectors will, of course, increase our knowledge of planetary atmospheres, but a new development has made possible such photoconductive detectors as the study of the reflected radiation from parts of a planet (e.g., the polar caps on Mars and the rings of Saturn). Work along these lines by Kuiper (*25*, *26*) and his associates has shown that the polar caps of Mars do not consist of solid carbon dioxide and are almost certainly composed of ice. Even more interesting are the indications (*26*) that Saturn's rings may consist of ice.

In the industrial field, lead sulfide cells open up new possibilities in high-speed radiation pyrometry. Lee and Parker (*27*) pointed out that temperatures as low as 100° C can be measured with fair accuracy, and temperatures of 500° C encountered on the wheels in rapid braking of locomotives can be followed continuously with an accuracy of about 1 per cent. An obvious extension of this technique can be made to the measurement of temperature at localized hot spots in various problems in the field of friction. An entirely different application (*28*) is the use of lead sulfide cells in the cinema industry for improved sound reproduction.

References

1. Sosnowski, L., Starkiewicz, J., and Simpson, O. *Nature*, **159**, 818 (1947).
2. Kicinski, F. *Chemistry & Industry*, **54** (1948).
3. Cashman, R. J. *J. Optical Soc. Am.*, **36**, 356A (1946).
4. Blackwell, D. E., Simpson, O., and Sutherland, G. B. B. M. *Nature*, **160**, 793 (1947).
5. Milner, C. J., and Watts, B. N. *Ibid.*, **163**, 322 (1949).
6. Simpson, O., and Sutherland, G. B. B. M. *Trans. Royal Soc.* (*London*), A, **243**, 547 (1951).
7. Moss, T. S. *Proc. Phys. Soc.* (*London*), B, **62**, 741 (1949).
8. Elliot[illegible] A. In *Electronics*. London: Pilot Press (1947).
9. Sutherland, G. B. B. M., and Lee, E. *Repts. Progress Phys.*, **11**, 144 (1947).
10. Smith, R. A. *Semi-conducting Materials*. 198 (1951).
11. Daly, E. F., and Sutherland, G. B. B. M. *Proc. Phys. Soc.* (*London*), A, **62**, 205 (1949).
12. Milatz, J. W. M., and Van der Welden, H. A. *Physica*, **10**, 369 (1943).
13. Lewis, W. B. *Proc. Phys. Soc.* (*London*), **59**, 34 (1947).
14. Jones, R. C. *J. Optical Soc. Am.*, **37**, 879 (1947).
15. Fellgett, P. B. *Ibid.*, **39**, 970 (1949).
16. Simpson, O. *Proc. Phys. Soc.* (*London*), **61**, 486 (1948).
17. Moss, T. S. *J. Optical Soc. Am.*, **40**, 603 (1950).
18. Gibson, A. F., and Moss, T. S. *Proc. Phys. Soc.* (*London*), A, **63**, 176 (1950).
19. Sutherland, G. B. B. M., Blackwell, D. E., and Fellgett, P. B. *Nature*, **158**, 873 (1946).
20. Mohler, O. C., *et al. Photometric Atlas of the Near Infra-red Solar Spectrum*. Ann Arbor: University of Mich. Press (1950).
21. Daly, E. F., and Sutherland, G. B. B. M. *Proc. Phys. Soc.* (*London*), **59**, 77 (1946).
22. Bullock, B. W., and Silverman, S. *J. Optical Soc. Am.*, **40**, 608 (1950).
23. Daly, E. F. *Nature*, **166**, 1072 (1950).
24. Kuiper, G. P. *Repts. Progress Phys.*, **13**, 247 (1950).
25. Kuiper, G. P., Wilson, W., and Cashman, R. J. *Astrophys. J.*, **106**, 243 (1947).
26. Kuiper, G. P. *The Atmospheres of the Earth and the Planets*. Chicago: Univ. Chicago Press (1949).
27. Lee, E., and Parker, R. C. *Nature*, **158**, 518 (1946).
28. Cashman, R. J. *J. Soc. Motion Picture Engrs.*, **49**, 342 (1947).

News and Notes

Arid Zone Research

The Second Session of the Advisory Committee on Arid Zone Research was held September 3–5, 1951, at Unesco House, Paris. The United Nations, the Specialized Agencies, and international nongovernmental scientific and engineering organizations with interests in arid zone research were invited to send representatives, and approximately 40 experts participated.

The session was opened by the chairman of the First Session, Richard L. Boke (USA). As chairman of the Second Session the committee elected L. Picard (Israel). The chairman designated Richard L. Boke, J. Pérès (France), and H. G. Thornton (United Kingdom) as a subcommittee to draft the report of the session.

The committee noted that the Institute of Biology (UK) was organizing in 1952 a Conference on the Biology and Productivity of Hot and Cold Deserts and recommended that its Fourth Session be held at the same place as the conference either immediately before or after it.

The committee took note of the report on the Symposium on Desert Research to be sponsored by the Research Council of Israel in 1952 and recommended that the director-general allocate a sum of $2,000 toward the publication of the proceedings of the symposium. Representatives of the Food and Agriculture Organization and Unesco reported on the exploratory mission to the Sidi Mesri Research Station, Libya. Reports were also submitted on the Saharan Research Centre, Beni-Abbes, Algeria; the Beni-Ounif Saharan Biology Station, Algeria; and the Jaswant College, Jodhpur, India.

The committee reviewed the maps showing the world distribution of arid and semiarid homoclimates prepared for Unesco by Peveril Meigs, noting that the maps had been approved by the International Geographical Union. The committee approved the list of

countries having arid and semiarid areas, regionally grouped, which had been submitted to Unesco by Dr. Meigs on behalf of the International Geographical Union, with minor modifications.

Having studied the reports reviewing hydrological research with special reference to underground water, submitted to Unesco by R. D. Dhir, Y. M. Simaika, H. F. Frommurze, R. K. Linsley, E. S. Hills, and G. Drouhin, the committee recommended that the director-general take steps to publish them.

The committee recommended the following program for 1953 and 1954:

1) To promote research on scientific and technical problems concerning the arid zone.
2) To collect and disseminate information on research being carried out on problems of the arid zone and on the organizations, scientists, and engineers engaged in such research.
3) To assist institutions designated by the Advisory Committee on Arid Zone Research in carrying out specific projects approved or recommended by the committee and falling within a coordinated program of fundamental arid zone research.
4) To organize, in collaboration with a member state, a symposium on a specific group of problems—with a Latin-American country in 1953, and with India in 1954.
5) To have studies carried out, with the approval of the Executive Board, on questions that may be submitted to the director-general by a member-state, the United Nations, or a specialized agency, provided funds for these studies are found outside the regular budget of Unesco. The committee recommended that the director-general consider in addition to the normal program for 1953 and 1954, the following subjects for study if more funds become available:
   (i) evolution of arid areas in the past and present,
   (ii) utilization of salt water,
   (iii) utilization of dew,
   (iv) artificial rain.

The committee also recommended that in 1952 Unesco delegate qualified experts to prepare reports reviewing the research carried out on plant ecology, as it pertains to arid and semiarid regions, based upon available published literature, as well as upon any information which Unesco may be able to collect. Eight reports are contemplated, embracing the major arid regions of the earth.

The committee accepted the offer extended by the government of Turkey to Unesco to cosponsor the symposium on Arid Zone Hydrology, with Special Reference to Underground Water in Turkey in the spring of 1952, and the invitation of the government of Turkey that the Third Session of the committee be held in conjunction with the symposium.

Condensed from the report by

RICHARD L. BOKE
J. PÉRÈS
H. G. THORNTON

Scientists in the News

M. L. Anderson has succeeded **E. P. Stebbing** in the chair of forestry at the University of Edinburgh. Dr. Anderson has directed instruction and research in British forestry practice at the Imperial Forestry Institute at Oxford since 1946.

Martin E. Blazina, Frank L. Meyer, and **Julius J. Wineberg,** students at the University of Illinois College of Medicine, have been awarded Beaumont Memorial prizes. The awards are made to students or faculty members who have made important research contributions and have been recommended for consideration by heads of departments in the College of Medicine. Beaumont Memorial Prizes were endowed by the late Frank Smithers, of Chicago, in memory of William Beaumont, famous nineteenth-century surgeon and physiologist. Three third-year students, **Allen H. Lefstin, Arthur S. Granston,** and **John H. Frenster,** have been awarded Yarros scholarships, which were established in honor of the late Rachelle S. Yarros by her husband, Victor S. Yarros, of La Jolla, Calif. Professor Yarros taught obstetrics and social hygiene at the College of Medicine prior to her retirement in 1938.

Francis Boyer, executive vice president, has become president, and **O. J. May,** vice president in charge of operations, has been made executive vice president, at Smith, Kline & French Laboratories. Mr. Kline, who has been president since 1921, will continue in the active management of the company as chairman of the board.

George J. Dienes, physical chemist formerly associated with North American Aviation, Inc., and Bakelite Corp., has joined the Physics Department of Brookhaven National Laboratory. He will use neutrons from the Brookhaven reactor, as well as other forms of radiation, to study the structure of metals and other solids, and the effects of these radiations on them.

Howard Evans has been appointed associate director of clinical research at Lakeside Laboratories, Inc., Milwaukee. He was formerly director of the Professional Service Department.

Frances A. Hellebrandt, of the Medical College of Virginia, has been made professor and head of the Department of Physical Medicine and Rehabilitation at the University of Illinois College of Medicine. Dr. Hellebrandt also is serving as chief of physical medicine and rehabilitation at the University of Illinois Research and Educational Hospitals. She has succeeded **H. Worley Kendell,** who resigned to accept a position as medical director of the Institute of Physical Medicine Rehabilitation at Peoria. Dr. Kendell will retain an appointment at the University of Illinois as clinical professor of physical medicine and rehabilitation.

Henrietta Herbolsheimer, chief of the Division of Maternal and Child Health of the Illinois Depart-

ment of Health, has been appointed an assistant professor of preventive medicine at the University of Chicago medical center. Dr. Herbolsheimer was on leave last year from the Department of Public Health to serve as a deputy director of the Illinois Civil Defense Agency. In this capacity, she had charge of planning medical and casualty services for the Illinois State Defense Plan.

L. E. Howlett, codirector, Division of Physics, National Research Council of Canada, has been named chairman of Commission I of the International Society of Photogrammetry.

Vladimir N. Ipatieff, director of chemical research for Universal Oil Products Company and director of the Ipatieff High Pressure and Catalytic Laboratory, Department of Chemistry, Northwestern University, has been named a Chevalier of the Cross of Lorraine and Companion of the Resistance. The French Association of the Knights of Cyprus and Jerusalem has also awarded Professor Ipatieff its Order.

Frederick G. Keyes has been elected to the office of treasurer of **Alfred Bicknell Associates, Inc.,** the scientific laboratory apparatus manufacturers of Cambridge, Mass. Dr. Keyes has served the company as director of research the past two years since his retirement as chairman of the Chemistry Department at MIT. **Arthur B. Lamb,** professor emeritus of Harvard University and editor for many years of the *Journal of the American Chemical Society,* has been elected vice president.

W. T. O'Gara, formerly field geologist with the Conselho Nacional do Petroleo do Brasil, is now paleontologist with the Corporación de Fomento de la Producción Chile, at Punta Arenas, Chile.

J. H. Parkin, director of the Division of Mechanical Engineering, National Research Council of Canada, was awarded the Engineering Alumni Medal at the recent triennial reunion of the Engineering Alumni Association of the University of Toronto. Early this year, when the Canadian government created the National Aeronautical Establishment, Mr. Parkin was appointed its first director.

Dean Rusk, Assistant Secretary of State for Far Eastern Affairs since March 1950, will become president of the Rockefeller Foundation. Mr. Rush will succeed **Chester I. Barnard** when the latter retires because of age limitation on June 30, 1952. This action was taken by the Board of Trustees of the Foundation at a meeting held at Williamsburg, Va.

The National Air Council Award for outstanding achievement in aviation research and experiment has been awarded to **John P. Stapp,** USAF (MC). The award is made annually to that member of the Air Force and that member of the Navy who have contributed most in the field of aviation research and experiment. The award is not restricted to medical research, but this is the second time aeromedical research activities have been so honored. The Navy recipient of the NAC award for 1951 is **Walter S. Diel,** for his work in organizing and directing the Navy's transonic flight program. Major Stapp was nominated for providing science with data on deceleration forces encountered in aircraft crashes.

Harold L. Stewart, chief pathologist of the Cancer Institute of the National Institutes of Health, was U. S. delegate to the International Cancer Research Commission, meeting Dec. 15–20 in Lisbon. He was selected by the *ad hoc* committee of the National Research Council, formed at the request of the National Cancer Institute, the American Cancer Society, and the American Association for Cancer Research. Accompanying Dr. Stewart was **Alexander Symeonidis,** a special research fellow from Greece, who directs the Geographical Pathology Unit at the National Cancer Institute. **E. V. Cowdry,** of the Washington University School of Medicine, was appointed alternate U. S. delegate and also attended the Lisbon conference.

Charles L. Thomas has joined the research and development staff of Sun Oil Company. For the past six years he has been director of research and development for the Great Lakes Carbon Corporation.

Charles F. Wagner, of Westinghouse Electric Corp., has been awarded the 1951 Edison Medal for "distinguished contributions in the field of power system engineering." The medal is awarded annually by an AIEE Committee as "an honorable incentive to scientists, engineers and artisans to maintain by their works the high standards of accomplishments" set by Thomas A. Edison. Dr. Wagner is the 41st recipient of the medal since it was established in 1904 by an organization of associates of Mr. Edison.

Orville Derby Commemorative medals have been presented on behalf of the Brazilian Government by Alberto Ericksen, former chief of the Divisão do Fomento, Departamento Nacional da Producão Mineral, to **William E. Wrather,** director of the U. S. Geological Survey, and to the following Geological Survey personnel: **William T. Pecora, George Switzer** (for the U. S. National Museum), **Alfred J. Bodenlos,** and **Mackenzie Gordon.** A medal will be mailed also to **Philip W. Guild,** who was not present at the ceremonies. Similar medals have been presented to the Geological Survey group now in Brazil by Alberto Lamago, director of the Divisão de Mineralogia e Geología, Departamento Nacional da Producão Mineral, in Rio de Janeiro. The awards were given for work completed on mineral projects in Brazil wherein Survey personnel are cooperating with the Brazilian National Department of Mineral Production.

The Institute of International Education has named **Louise L. Wright** director of its Midwest office. The new office in Chicago, established with the aid of the Ford Foundation, will coordinate international exchange of students, teachers, and specialists in Midwestern states.

Grants and Fellowships

Oak Ridge Institute of Nuclear Studies, which is administering the fellowship program of the **Atomic Energy Commission**, has announced the names of 300 predoctoral and 43 postdoctoral fellows. Of the former, 223 are in the physical sciences, and 77 in the biological sciences. Among the postdoctoral fellows, 21 are in the physical sciences, 17 in the biological, and 5 in the medical sciences. Eighty-one were extensions of 1950–51 predoctoral fellowships. Several scientists will study abroad. Among them are Richard A. Ferrell, who will work at the Max Planck Institute under Werner Heisenberg; Ben R. Mottelson, who will work under Niels Bohr; and Norton M. Hintz, who is studying with Otto Frisch.

Commonwealth Scientific and Industrial Research Organization is offering a number of two-year studentships for postgraduate training in science, engineering, and related subjects. Up to 8 overseas traveling awards will be made and up to 16 in Australia.

Thirteen graduate students have received **Humble Oil & Refining Company** fellowships for the 1951–52 academic year at A & M College of Texas, Rice Institute, University of Texas, University of Oklahoma, Louisiana State, and MIT. Each fellow is selected by the participating school from among its own students. Civil, mechanical, chemical, and petroleum engineering, physics, geology, and chemistry are among the fields of study.

The **A. W. Mellon Educational and Charitable Trust** has given $250,000 to the University of Pittsburgh to aid the five-year program of the Western Psychiatric Institute and Clinic. Additional funds for the five-year program have been received from the Maurice and Laura Falk Foundation ($250,000), the Sarah Mellon Scaife Foundation ($75,000), and the Howard Heinz Endowment ($25,000). Three specialists are participating in the research of the institute: Henry W. Brosin, medical director; I. Arthur Mirsky, head of the Research Division; and Benjamin Spock, professor of child development.

Sharp & Dohme has awarded two grants for medical research from the $50,000 recently created for the advancement of fundamental research in biology, microbiology, and chemistry (SCIENCE, **114**, 84 [1951]). A 3-year grant, in the amount of $6,000, for virus research, went to L. O. Krampitz, director of microbiology, Western Reserve, and another $6,000 for work on bacterial metabolism, to E. E. Snell, of the University of Texas.

Westinghouse Educational Foundation will award 20 to 40 fellowships to secondary-school science teachers for participation in a special six weeks' summer program at Carnegie Institute of Technology. Full-time staff members of the College of Engineering and Science will have charge of the course. Further information may be obtained from the Carnegie director of admissions.

In the Laboratories

American Can Company has established a new Research and Technical Service Department, of which B. S. Clark, formerly director of research, has been made scientific director. The new department will consist of Research, Development, Technical Service, and Agronomy divisions. R. W. Pilcher has been appointed director of the Research Division, D. F. Sampson, manager of the Technical Service Division; F. W. Geise remains as manager of the Agronomy Division. The Development Division has not yet been organized. Among projects to be taken up by the new department will be studies in the cold sterilization of canned foods by gamma radiation from radioactive waste material, and a search for alternative raw materials of various kinds.

American Cyanamid has appointed T. F. Cooke manager of the Application Laboratories in the Textile Resin Department, succeeding L. A. Fluck, who has become assistant to Richard E. Sumner.

Borden's Chemical Division in Philadelphia has begun construction of a new $365,000 research laboratory, scheduled for completion next June. Research emphasis will be on the development of new techniques and chemical products such as synthetic resins, coatings, and binders, useful in various ways to the rearmament program.

Hercules Powder Company will construct a $2,500,000 plant for the manufacture of toxaphene at Henderson, near Las Vegas, Nev. Operations are expected to begin early in 1953, increasing the present output of the chemical by approximately 25%.

Among new appointments at **Lederle Laboratories Division**, American Cyanamid Company, are J. Charles Cavagnol, chemist, formerly associate professor of chemistry, University of Kentucky; Ralph F. Elliott, animal nutritionist, of the same university; and Arthur W. Tallman, who will be head of the Human Bacteriological Department. Dr. Tallman was formerly head of Squibb's Department of Biological Production.

National Research Corporation has added James H. Gardner, of Shell Oil Company and the University of Houston, to its Petrochemical Research Department. He will supervise the physical chemistry phases of the research program undertaken jointly with Electric Bond and Share and United Gas, directed toward the development of new chemicals from natural gas. Thomas R. Steadman, of B. F. Goodrich, has joined the department to supervise the organic chemistry phases of the research.

Whittier Laboratories, Division Nutrition Research Laboratories, Inc., has appointed Robert H. Broh-Kahn medical director. Dr. Broh-Khan has been medical director of Bristol Laboratories, Syracuse, N. Y., and associate professor of medicine at the State University of New York Medical Center, Syracuse.

Meetings and Elections

The annual meeting of the **American Academy of Forensic Sciences** will be held Mar. 6–8 at the Biltmore Hotel, Atlanta, Ga. All those interested in presenting papers are urged to submit titles immediately to the program chairman, A. W. Freireich, 180 Hempstead Ave., Malverne, N. Y. Orders for the printed proceedings of the 1950 annual meeting may be filed with Ralph E. Turner, Department of Police Administration, Michigan State College, East Lansing.

The **British Commonwealth Scientific Official Conference,** first to be held outside the United Kingdom, will open in Canberra on Feb. 18 and close in Melbourne on Mar. 7. Leaders in the fields of industrial agricultural, and medical research will attend and plan collaboration in civil scientific work. The formal sessions will be broken by visits to enable delegates to study developmental problems. CSIRO is in charge of local arrangements.

The **Colston Research Society** will hold a Symposium on the Suprarenal Cortex at Bristol, Eng., Mar. 31–Apr. 4. The provisional list of speakers includes F. Verzar (Basle), George W. Thorn (Harvard), C. H. Li (Berkeley), Harry Robinson (Merck), Dwight J. Ingle (Upjohn), and Hudson Hoagland (Worcester Foundation). Those interested in attending should write to J. M. Yoffey, Department of Anatomy, The University, Bristol, 8.

Conveyor Equipment Manufacturers Association, at its annual meeting in Hot Springs, Va., elected G. Walter Ostrand president to succeed L. B. McKnight. R. C. Sollenberger, staff head of the association since 1945, was re-elected executive vice president. Harry C. Davis was elected vice president, R. F. Tomlinson treasurer, and Lee Sekulski secretary for a second term. J. A. Jeffrey, J. E. McBride, and Mr. McKnight were elected to the Executive Committee.

Heinz Hartmann, of New York, succeeds Leo Bartemeier as president of the **International Psychoanalytic Congress,** which met in Amsterdam in August. Ruth Eissler succeeds Grete Bibring as secretary, and Max Gitelson was elected treasurer. The 18th congress will be held in England in 1953.

At the AAAS meeting in Philadelphia, **Sigma Delta Epsilon,** national fraternity for graduate women in science, announced that its 1951 Research Award had been given to Margaret Green, of Ohio State, for a paper published in the *Journal of Morphology.* Marie Farnsworth won the Home Research award, established last year, for a paper on ancient pigments that appeared in the *Journal of Chemical Education.* Jay Traver won honorable mention. SDE, which is celebrating its 30th anniversary this year, presented certificates of outstanding service to Martha Doan (chemist), Sophia H. Eckerson (microchemist), Stella Hague (botanist), Rosalie Parr (chemist), Laetitia M. Snow (bacteriologist and botanist), and Bertha Van Hoosen (surgeon).

The **Sociedad Cubana de Psicoterapia** has elected José A. Bustamante president, Oscar Sagredo president-elect, José Perez Villar and Francisco Aguero secretaries, and Armando Cordova and Carlos Acosta treasurers. Miguel A. Nin was elected secretary.

Technical Papers

The Inhibition of the Development of Histamine Sensitivity in Mice Immunized with *Hemophilus pertussis*

Elizabeth H. Thiele and Lee F. Schuchardt

Department of Bacteriology, Research Division, Sharp & Dohme, Inc., Glenolden, Pennsylvania

Parfentjev and Goodline (*1*) and, later, Halpern and Roux (*2*) showed that mice immunized against *Hemophilus pertussis* concurrently became hypersensitive to histamine. They showed further that this increase in sensitivity to histamine, which is of a 100- to 200-fold magnitude, can be blocked effectively by injection of antihistaminic drugs such as Bromothen or Phenergan given 15 min prior to the injection of a lethal shocking dose of histamine.

This communication expands the above observations by the examination of the action of another type of compound, described by Martin *et al.* (*3*) and Moss *et al.* (*4*) as capable of inhibiting histidine decarboxylase. These authors found that certain aglycone flavonoid compounds of the Vitamin P group, including quercitin and D-catechin, possess this ability, and the latter, when given prophylactically for 19 days, prevented guinea pigs from becoming sensitized to horse serum but did not protect nonsensitized, normal animals challenged with histamine.

By using the method of Parfentjev and Goodline for increasing the sensitivity of mice to histamine, it has been found that repeated treatment with quercitin (*5*) during the period between immunization and histamine challenge could inhibit the development of histamine hypersensitivity, though this compound was unable to block the lethal action of histamine when given immediately prior to histamine challenge. In contrast to this, the antihistaminic Chlorotrimeton was found to be effective as a blocking agent but was not able on repeated administration to inhibit the develop-

ment of histamine sensitivity. The following experiments illustrate the results obtained.

The inability of quercitin to block the lethal action of histamine is demonstrated in the experiment outlined below. One hundred and fifty mice were immunized intraperitoneally with 2 billion cells of an antigenic *H. pertussis* vaccine, and 4 days later 100 of them received 1 mg quercitin intraperitoneally, the remainder serving as sensitized controls. Two groups of the treated mice were challenged with graded doses of histamine, using 10 mice/histamine dose, one group 2 hr after quercitin, the other 6 hr after quercitin. The LD_{50}, calculated by the method of Reed and Muench (*6*), was 0.08 mg for both groups, and for the 50 sensitized controls 0.07 mg. In this experiment quercitin exhibited no histamine-blocking properties. The possibility that these findings could be explained by the lack of absorption of quercitin seems unlikely in view of the following experiment, which can be explained only by the absorption of quercitin from the peritoneal cavity.

The experiment was for the purpose of demonstrating the ability of quercitin to inhibit the development of histamine hypersensitivity. Two groups of mice were immunized as before. The animals of Group I received daily intraperitoneal injections of 1 mg quercitin suspended in propylene glycol, and the animals of Group II received only propylene glycol and served as sensitized controls. After 4 days and approximately 17 hr after the last injection of quercitin, the mice of each group were challenged with graded doses of histamine. The LD_{50} for Group I was 1.2 mg of histamine, for Group II, 0.06 mg. Nonimmunized normal mice gave an LD_{50} of 12.5 mg. These results indicated that quercitin-treated mice would tolerate approximately twenty times more histamine than the immunized controls, although histamine hypersensitivity was not obliterated completely.

Chlorotrimeton, as an example of an antihistaminic, was tested both for its blocking properties and for its ability to inhibit the development of histamine sensitivity. These properties were demonstrated in the following manner: On the fourth day following immunization, half of a group of 100 immunized mice received an intraperitoneal injection of 0.3 mg Chlorotrimeton. Two and one-half hr later these mice and the immunized controls were challenged with graded doses of histamine. The LD_{50}s were 0.96 mg and 0.07 mg, respectively. When Chlorotrimeton was given in this dosage daily during the period of histamine-sensitivity development as in the quercitin experiment described above, it was found that histamine gave an LD_{50} of 0.12 mg in both the treated and the control groups. Thus, Chlorotrimeton, though capable of blocking hypersensitivity to histamine, would not prevent such hypersensitivity from developing.

Since previous workers (*1*) have shown that the ability to cause histamine hypersensitivity is a property of pertussis vaccines of demonstrable antigenicity, it was of interest to determine whether the inhibition of the development of histamine hypersensitivity would influence immunity. Mice were immunized as before and divided into two groups, one of which received daily injections of quercitin; the other group, serving as sensitized controls, received daily injections of the propylene glycol solvent. On the seventh day mice from each group were challenged with graded doses of histamine; it was found that in the quercitin-treated mice the LD_{50} was 1.02 mg, and in the controls it was 0.08 mg. The remaining mice from each group were challenged by intracerebral injections with approximately 100 LD_{50}s of pertussis organisms. Thirteen out of 15 (87%) survived in the quercitin-treated mice, and 19 out of 19 (100%) survived in the immunized controls. These results suggest that the suppression of the development of histamine sensitivity had not interfered seriously with immune phenomena. It should be noted that the mice under quercitin treatment were sickly and showed signs of toxicity, some dying before completion of the experiment. The toxicity was traced, in part, to the amount of propylene glycol used in the suspending menstruum and, in part, to the quercitin.

The data presented indicate the possibility that the diminution of hypersensitivity to histamine may be achieved by the inhibition of the development of such sensitivity rather than by the neutralization of the histamine reaction. It would appear further that this may be accomplished without serious interference with the development of immunity.

References

1. Parfentjev, I. A., and Goodline, M. A. *J. Pharmacol. Exptl. Med.*, **92**, 411 (1948).
2. Halpern, B. N., and Roux, J. *Comp. rend. soc. biol.*, **143**, 923 (1949).
3. Martin, G. J., *et al. Arch. Biochem.*, **21**, (1), 177 (1949).
4. Moss, J. N., Beiler, J. M., and Martin, G. J. *Science*, **112**, 16 (1950).
5. Wunderlich, A. *Arch. Pharm.*, **246**, 224 (1908).
6. Reed, L. F., and Muench, H. *Am. J. Hyg.*, **27**, 493 (1938).

Manuscript received August 6, 1951.

The Life Span of Leucocytes in the Human[1]

Daniel L. Kline and Eugene E. Cliffton

Section of Oncology, Department of Surgery, and Department of Physiological Chemistry, Yale University School of Medicine

The life span of leucocytes has been measured by many techniques, most of which involved unphysiological experimental conditions. Using these methods, the life span has been estimated to vary from less than an hour to 3 weeks, depending upon the method used.

Shemin and Rittenberg (*1*), using a more physiological method, estimated the life span of red blood cells by measurement of the incorporation of glycine, labeled with N^{15}, into hemin. Because of the stability

[1] Supported by Institutional Research Grant #47B of the American Cancer Society.

of the latter compound an accurate measurement of the red blood cell life span was obtained.

A similar method has been developed for estimation of the life span of leucocytes by measurement of the incorporation of P^{32} into the desoxypentose nucleic acids (DNA) of the leucocytes. The inertness of P^{32} in the DNA molecule after formation of the leucocytes has been found to be similar to the stability of N^{15} in hemin of the red blood cells, permitting a close estimation of the life span.

Hospitalized patients who had had a complete clinical work-up and were found to have normal total and differential white blood counts, who were free of diseases known to affect the white blood cells, and who could be studied for a prolonged period without receiving significant drug or other treatment were chosen for study. They primarily included patients with cardiovascular diseases.

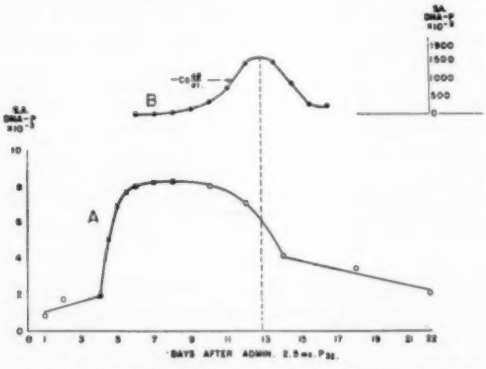


FIG. 1. Life span of leucocytes in the human. Curve *A*, 0 = specific activity of DNA (cpm/mg P) $\times 10^{-3}$; *x* = calculated points from equation $C(t) = Co\ (1 - e^{-\lambda t}) + 1900$, where $Co = 6400$ and $\lambda = 1.53$. Curve *B*, probability of cell survival time.

Each of 6 patients was given, by mouth, 2.5 mc of P^{32} as inorganic phosphorus. At 24 and 48 hr after administration, and every 2 days thereafter for periods up to 3 weeks, 50 ml of blood was drawn in a dry syringe and transferred immediately to a heparinized test tube. The blood was drawn at approximately the same hour in the morning. The red blood cells were settled by the addition of fibrinogen (*2*), the leucocytes were pipetted off, centrifuged, resuspended in their own plasma, and then centrifuged in a plastic straw. The contents of the straw were frozen, and a clean area of packed white blood cells was cut from the straw with a razor blade. The cells obtained were weighed, and the DNA fraction was precipitated by the method of McCarter and Steljes (*3*). The DNA was reprecipitated, dissolved, and then digested in nitric acid. Phosphorus was estimated by the method of King (*4*). For measurement of radioactivity the phosphorus was precipitated as ammonium molybdophosphate and filtered through sintered glass counting disks. The samples containing radioactivity were counted in a Tracerlab proportional flow counter to an accuracy of ±2 or 3%, except for a few with low activity, where the accuracy was ±5%.

In Fig. 1, curve *A*, the specific activity of the DNA-P^{32} (cpm/mg P) is plotted against time in days (open circles). Each point represents the average of determinations on 2–6 different individuals. The type of curve obtained, as has been pointed out by Shemin and Rittenberg, will result only if the uptake and release of isotope is not a random process, but depend on a selective factor such as the age of the cells. Osgood *et al.* (*5*) have recently shown that P^{32} is not incorporated into the DNA of mature leucocytes in tissue cultures.

By plotting the change in specific activity against time $\left(-\frac{dC}{dt}\right)$, an approximation of the life span of the white cells, based on the assumption that the release of labeled cells into the circulation is instantaneous, may be obtained. A correction to allow for the fact that the labeled cells are not discharged simultaneously may be calculated through the use of an equation to fit the early part of the curve, from the fourth to the eighth days. The equation $C(t) = Co(1 - e^{-\lambda t}) + 1900$, where $C(t)$ is the specific activity at time t, and Co and λ are constants whose values are 6,400 and 1.53, respectively, satisfies these conditions. The points obtained from this equation are shown on curve *A*, Fig. 1, as *x*'s. Where $\phi(t)$ is the probability that a white cell will have a life span greater than t, it has been shown (*1*) that

$$Co\frac{d\phi}{dt} = \frac{1}{\lambda}\frac{d^2C}{dt^2} + \frac{dC}{dt}.$$

A plot of $-Co\frac{d\phi}{dt}$ against time gives curve *B*, Fig. 1, which yields an average life span of 12.8 days from the time of administration of the isotope and a value of 8.8 days for the time the labeled leucocytes are in the circulation in large numbers. The difference of 4 days may be interpreted as the time the bulk of the cells containing labeled DNA remained in the bone marrow. This is in accord with the observation that white cells continue to be released for 3–5 days following irradiation (*6*).

A life span of 12.8 days is considerably longer than the values that have appeared in recent literature (*6–8*). It should be borne in mind, however, that the shorter times were measurements, not of the life span of white cells, but of the time required for the replacement of cells that had been removed by cannulation or destroyed by irradiation. There is ample evidence (*9*) that discharge of stores of mature leucocytes from the bone marrow could satisfactorily explain the extremely short "life span" reported in these experiments.

The values reported here represent the average of all white blood cell types. If all these cell types persist in the circulation for days, it is impossible to explain the observed depression in lymphocyte and eosinophil levels after administration of ACTH and cortisone on the basis of inhibition of production of

these cells. Although it does not appear likely that the lymphocytes and eosinophils are completely different in their life span from the other leucocytes, final certainty on this point must await further experimentation.

References

1. Shemin, D., and Rittenberg, D. *J. Biol. Chem.*, **166**, 627 (1946).
2. Gray, S. J., and Mitchell, E. B. *Proc. Soc. Exptl. Biol. Med.*, **51**, 403 (1942).
3. McCarter, J. A., and Steljes, E. L. *Can. J. Research, E.*, **26**, 333, (1948).
4. King, E. J. *Biochem. J.*, **26**, 292 (1932).
5. Osgood, E. E., *et al. Science*, **114**, 95 (1951).
6. Lawrence, J. S., Ervin, D. M., and Wetrich, R. M. *Am. J. Physiol.*, **144**, 284 (1945).
7. Van Dyke, D. C., and Huff, R. L. *Ibid.*, **165**, 341 (1951).
8. Adams, W. S., Saunders, R. H., and Lawrence, J. S., *Am. J. Physiol.*, **144**, 297 (1945).
9. Bunting, C. H. *Physiol. Rev.*, **2**, 505 (1922).

Manuscript received August 6, 1951.

Significant Spatial Distribution Patterns of Minerals in the Coeur d'Alene District, Idaho

Thomas W. Mitcham

American Smelting and Refining Company, Vanadium, New Mexico

In the Silver Belt of the Coeur d'Alene mining district, deeply buried high-grade oreshoots are found in carbonate-quartz veins. A plan map of the area has been published (*1*), and the geological problems involved in ore-search have been discussed (*2*).

A spatial distribution study has been made of the minerals of the area to determine which have distribution patterns indicative of the proximity of ore. Such minerals are called "indicators." The genesis of each mineral has been interpreted as an aid in the evaluation of the spatial distribution patterns.

Disseminated arsenopyrite forms envelopes around a number of the highest grade oreshoots. In horizontal or vertical cross sections, these envelopes have an average width of less than 15 ft; viewed normal to the plane of a vein, an envelope would appear as a halo of roughly 500-ft radius around an oreshoot. Similarly, late hydrothermal chlorite is considered to be an indicator; however, it is rather sporadically scattered in zones which tend to be umbrellalike in form above oreshoots, and which appear to extend as far as 3,000 ft above ore in some cases. Sericite and carbonates of prehydrothermal-vein origin have a negative significance as indicators; i.e., little ore has been found in areas where these minerals are concentrated. Also, since beds rich in detrital quartz are the best ore horizons, such quartz is considered to be an indicator of limited practicability.

In an attempt to clarify the origin of chlorite, six genetic types of chlorite are defined in the Coeur d'Alene District. These are chlorite in detrital biotite; diagenetic chlorite in certain strata; early, hydrothermal-vein chlorite; contact-metamorphic chlorite in and near the monzonitic intrusives; late, hydrothermal-vein chlorite; and chlorite resulting from the alteration of diabase and lamprophyre dikes.

The hydrothermal-vein history of the district is divided into three stages. In chronological order these are: the bleaching alteration stage, the carbonate-quartz stage, and the sulfide stage. The hydrothermal bleaching alteration of large areas of the country rock is largely the destruction of the rock pigments, and no strong sericitization appears to be involved, as previously believed. Regionally, the only exposed sedimentary rocks are those of the Algonkian Belt series; sericite is a major constituent of these rocks. If additional sericite is formed in the localized, bleached areas of the Algonkian rocks, it is a relatively negligible amount.

References

1. Shenon, P. J., and McConnel, R. H. *The Silver Belt of the Coeur d'Alene District, Idaho. Idaho Bur. Mines Geol. Pamph. 50* (1939).
2. Sorenson, R. E. *Eng. Mining J.*, **149**, (7), 70 (1948).

Manuscript received August 10, 1951.

DDT Resistance in Korean Body Lice[1]

Herbert S. Hurlbut, Robert M. Altman, and Carlyle Nibley, Jr.

Fleet Epidemic Disease Control Unit No. 1 and 37th Preventive Medicine Company, Eighth U. S. Army, Korea (EUSAK)

Contrary to expectation, routine application of 10% DDT powder to a large group of Korean military personnel during the winter and spring of 1951 resulted only in an increase of infestation with the body louse (*Pediculus humanus corporis* Deg.). The method used was essentially that employed by Soper *et al.* (*1*) in 1943, except that power dusters were used. The dust is applied without the removal of clothing. The DDT came from various sources, including a large stock of American manufacture that had been in storage for 5 or 6 years. Tests with mosquito larvae, however, demonstrated that it had retained its full insecticidal potency. The diluents most commonly used were talc and pyrophyllite.

The group of men treated increased rapidly in size during the first 3 months, then remained relatively stable. By the end of the second month it was possible to replace clothing worn by new arrivals with uninfested clothing. The number of layers of garments to be treated was thereby materially reduced. Living conditions were steadily improved so that bathing and clothes-washing facilities became readily available by the fourth month.

Despite these improvements, and the weekly application of DDT louse powder to all personnel, the percentage of infested persons increased steadily. During

[1] The opinions and assertions contained in this article are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Department of the Army.

TABLE 1

REARING OF BODY LICE ON CLOTH IMPREGNATED WITH DDT

	Test 1		Test 2	
	0.1% DDT	Control	0.1% DDT	Control
Total newly hatched lice at beginning of test	153	58	189	54
Percentage surviving to adult stage, 15 days at 80°–90° F	34	67	36	83
Percentage eggs hatching	$\frac{270}{383} = 70$	$\frac{430}{541} = 79$	$\frac{250}{376} = 66$	$\frac{271}{367} = 74$

the month of May, the fifth month of routine application, over 34,000 lbs of 10% DDT powder were used. The percentage of infestation by weeks for the month of May as determined by a random check of about 3% of the men was 35.5, 49.2, 51.0, and 42.4, respectively.

To determine whether more frequent application would give better results, a segregated group of 40 infested men was treated every third day for 15 days. Another group of 40 men, 20 of whom were infested and 20 apparently uninfested, were treated similarly and housed together in a separate tent. On the fifteenth day 35 were still infested in the first group and only 5 remained uninfested in the second group.

Impregnation of clothing and blankets by immersion in a 2% DDT-xylene emulsion was somewhat more effective, but not sufficiently so to merit adoption as a control measure. In a segregated group of 84 men whose effects were so treated, daily counts showed that the percentage of infested individuals dropped from 68% before treatment to 17% on the eighth day after treatment, then increased to 38% by the fourteenth day. Observations were discontinued at this point because it was not practicable to keep the group segregated for a longer period.

In laboratory tests 3 samples of 10% DDT louse powder applied to cloth at the rate of 0.021 g/sq in. gave mortalities for adult lice which ranged from 33 to 65% in 24 hr, with 27–45% remaining normal. Nine such tests were performed, using 20 lice per test. A fourth sample containing 5% DDT powder in Pyrax, kindly furnished by W. V. King, U. S. Department of Agriculture, Orlando, Fla., and known to be of acceptable potency against a standard laboratory strain of body lice, was tested in a similar manner. Ten tests, using 20 lice each, gave an average mortality of 46%, with 34% remaining normal after 24 hr exposure. When lice were confined within treated sleeves, which could be worn, thus permitting normal feeding, there were 41.5% normal test lice and 48% normal controls at the end of 48 hr in one test, and 60.5 and 61.7%, respectively, in a second. Under similar test conditions a powder containing 0.25% DDT gives 100% mortality in a standard laboratory strain of lice (*2*). The second test utilized the sample of proved potency previously mentioned. Four hundred lice and 10 subjects were employed in each test.

Lice were reared through their complete life cycle and produced a large number of viable eggs on cloth impregnated with 0.1% DDT solution in acetone (Table 1).

Cloth impregnated with a .05% solution is lethal to a standard laboratory strain (*3*). The solution of DDT used to impregnate the cloth was tested against the fourth instar larvae of *Anopheles sinensis*, a highly sensitive insect, and in two trials gave 83 and 90% mortality, respectively, in 24 hr, in a concentration of 1 part in 10 million. This DDT had been in storage as a 10% powder in talc for 5 years. Chemical analysis gave the DDT content as 10.4% by weight.

Since 1947 DDT resistance in houseflies has been reported from numerous localities where DDT has been in use. Laboratory experiments have demonstrated that resistant strains can be developed by selective breeding (*4*), and this has been interpreted as indicating that such a process occurs in nature. It seems probable that an analogous condition exists in the body louse. Hitherto, great dependence has been placed on DDT for the control of typhus. It now appears to be of uncertain value, being unsuitable for this purpose in some localities.

References

1. SOPER, F. L., *et al. Arch. inst. Pasteur Algérie*, **23**, 183 (1945).
2. BUSHLAND, R. C., *et al. J. Econ. Entomol.*, **38**, 210 (1945).
3. JONES, H. A., MCALISTER, L. C., and KNIPLING, E. F. *Ibid.*, 217.
4. KING, W. V., and GAHAN, J. B. *Ibid.*, **42**, 405 (1949).

Manuscript received September 18, 1951.

Transition Energy Determination for Orbital Capture

P. R. Bell, Josef M. Jauch, and Judith M. Cassidy

Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee

An element decaying by orbital electron capture to the ground state of the daughter element has x-rays of the daughter element as its principal detectable emission. There are, however, undetectable neutrinos and a weak but detectable γ-ray continuum (*1*). This spectrum is analogous to the continuous γ-ray, generally called "internal bremsstrahlung," accompanying β-ray transitions (*2, 3*). The spectrum of the γ-rays accompanying the β-transitions extends up to the maximum energy of the β-rays, and in the K-capture transitions the spectrum extends to the transition energy plus the energy obtained from the K-electron captured by the nucleus. The energy from the K-electron is the rest energy of an electron (0.511 mev) less the K-orbit binding energy.

The shape of the γ-ray spectrum to be expected

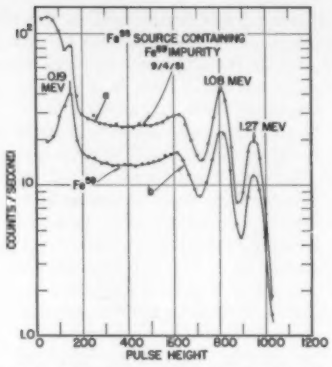


FIG. 1. Pulse height spectrum of Fe^{55} and Fe^{59} γ-rays.

from an allowed transition has been calculated by Morrison and Schiff (*1*) and by Jauch (*4*) and is given by the relation

$$N(\omega)\,d\omega = C(\omega)\,\frac{\alpha}{\pi m_o{}^2c^4}\,\frac{\omega}{W_o{}^2}\,(W_o-\omega)^2 d\omega, \qquad (1)$$

where $N(\omega)$ is the number of photons lying in the energy interval $d\omega$ at energy ω. W_o is the maximum photon energy which is related to the energy of transition E_o by Eq (2):

$$W_o = E_o + m_oc^2 - E_k, \qquad (2)$$

where m_oc^2 is the self-energy of an electron and E the K-shell binding energy. The factor $C(\omega)$ is a complicated function that is slowly varying except at very low energies. The inner bremsstrahlung spectrum is quite weak; the total number of photons goes as $W_o{}^2$ (*4*) and is about 3×10^{-5}/disintegration for Fe^{55}. The inner bremsstrahlung have been detected from Fe^{55} by Bradt *et al.* (*5*), and their average energy estimated as 70 kev, yielding a transition energy of 150 kev.

We have measured a sample of Fe^{55} (containing a small amount of Fe^{59}) with a scintillation spectrometer (*6–7*), using a N_aI-Tl phosphor. Fig. 1 (*a*) shows the pulse spectrum obtained. Fig. 1 (*b*) is the pulse spectrum of a small sample of Fe^{59}. The low energy end of 1 (*a*) shows the continuous γ-ray inner bremsstrahlung spectrum. The strong peak at 190 ± 5 kev in both curves is the missing crossover γ-ray of Fe^{59} not previously reported. Other runs of these two samples were made at higher gain, and the Fe^{59} contribution was subtracted to obtain the Fe^{55} radiations. Such a spectrum is shown in Fig. 2.

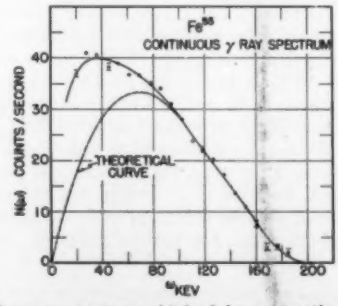


FIG. 2. γ-ray spectrum obtained by subtracting the Fe^{59} curve from the spectrum of impure Fe^{55}. The theoretical curve was obtained from the straight line in Fig. 3.

An inspection of Eq (1) shows its similarity to the relation for the β-ray distribution given by the Fermi theory. If the experimental $N(\omega)$ is treated in the same way as done for β-rays by Kurie, Richardson, and Paxton (*8*), we obtain

$$\frac{N(\omega)\text{exptl}}{C(\omega)\omega} = K(W_o-\omega), \qquad (3)$$

where K is a constant. Since $C(\omega)$ is slowly varying, we may to a first approximation consider it constant.

Fig. 3 shows the plot resulting from the data of

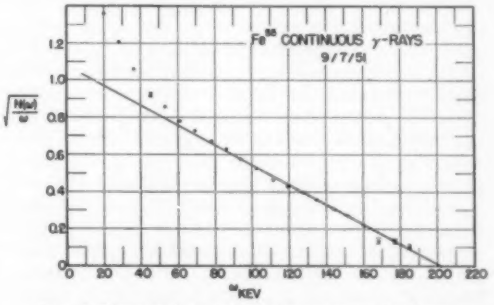


FIG. 3. Linearized plot of continuous γ-ray spectrum.

Fig. 2. It is approximately linear, showing that the transition is allowed, and intercepts the energy axis at $W_o = 206\pm20$ kev.

This value for the transition energy including the K-electron energy must be considered approximate, since correction has not been made for resolution and efficiency. Fortunately the efficiency of the crystal (2.5 cm thick) is very nearly unity for this energy range. The Mn x-rays have been absorbed out by the crystal container and a lucite absorber inserted to stop the Fe^{59} electrons.

The energy of this transition can be obtained from the Q value for the $Mn^{55}(p,n)Fe^{55}$ reaction. Using the value of $Q=1.006$ mev reported by Stelson and Preston (*9*), the value obtained is $W_o = 217\pm10$ kev, with which our value is in good agreement.

This new method for K-capture transition energies is now being extended to other isotopes.

References

1. MORRISON, P., and SCHIFF, L. I. *Phys. Rev.*, **58**, 24 (1940).
2. WU, C. S. *Ibid.*, **59**, 481 (1941).
3. KNIPP, J. K., and UHLENBECK, G. E. *Physica*, **3**, 425 (1946).
4. JAUCH, J. M. ORNL-1102.
5. BRADT, H., *et al. Helv. Phys. Acta*, **19**, 222 (1945).
6. BELL, P. R. *Science*, **112**, 7 (1950).
7. BELL, P. R., and CASSIDY, J. M. *Phys. Rev.*, **79**, 173 (1950).
8. KURIE, F. N. D., RICHARDSON, J. R., and PAXTON, H. C. *Ibid.*, **49**, 368 (1936).
9. STELSON, P. H., and PRESTON, W. M. *Ibid.*, **83**, 468 (1951).

Manuscript received September 19, 1951.

Oxidative Dissimilation of Nonnitrogenous Compounds in *Acetobacter suboxydans*[1]

Tsoo E. King and Vernon H. Cheldelin[2]

Department of Chemistry,
Oregon State College, Corvallis

Since the isolation of *Acetobacter suboxydans* by Kluyver and De Leeuw in 1924 (*1*), this organism has been used extensively in several fermentations. It is characterized by restricted oxidative capacity; thus, yields of sorbitol from sorbose are high (70% or over), and nearly quantitative conversion of glycerol to dihydroxyacetone (DHA) has been obtained (*2, 3*). Similarly, more than a score of other polyhydroxy compounds are oxidized to the corresponding monoketones (*1–6*).

Work in this laboratory has focused upon *A. suboxydans* metabolism because of the organism's preferential use of conjugated forms of pantothenic acid (PAC [*7*]; coenzyme A [*8, 9*]) over the free vitamin. Since this vitamin (or one of its conjugates) is essential to the growth of *A. suboxydans*, the present study has attempted to locate in the organism certain processes that are known to be coenzyme A-dependent. Failure to observe these, together with the discovery that resting *A. suboxydans* cells can cause extensive dissimilation of sorbitol or glycerol beyond sorbose or DHA, have emphasized the need for further study of the oxidative patterns that exist for this organism. The preliminary results are summarized in the following paragraphs.

A. suboxydans cells[3] were grown in a purified medium essentially the same as previously described (*10*). The cells were harvested by centrifuging, washed at 4° C, and immediately dried *in vacuo* from the frozen state. The dried cells were then used as test material. All oxidative studies were performed by standard manometric techniques in a Warburg apparatus.

Coenzyme A (CoA) participation in oxidative metabolism has been indicated at the point of entry of a C_2 unit (at the oxidation level of acetate) into the Krebs cycle (*11, 12*). Although hot water extracts of the dried cells contained liberal amounts of CoA,[4] all attempts to oxidize acetate or any member of the cycle by *A. suboxydans* failed completely, even in the presence of glycerol as a potential "sparker." The inert character of acetate, as well as the absence of other CoA-dependent processes, was further indicated by the failure of the organism to form citrate or to acetylate sulfanilamide,[5] even in the presence of an external source of CoA and adenosine triphosphate (ATP). Under such conditions both activities were exhibited by liver systems, with or without extra CoA and ATP. Barring a complete lack of permeability of the cells toward all these substances, it would appear that the citric acid cycle, if it operates at all, does not play a major role in the oxidative metabolism of *A. suboxydans*; also, the function of CoA in this organism still remains to be established.

The oxidation of various nonnitrogenous substrates was then studied. Lactic and pyruvic acids were dissimilated in nearly quantitative fashion to give equimolar quantities of acetic acid and CO_2. The R. Q. of the former oxidation was about 1, whereas with pyruvic acid it approached 2. Ethanol oxidation involved the uptake of 2 oxygen atoms, with no CO_2 evolution, as reported by other workers (*2, 16*). However, the oxidation of glycerol by resting cells in phosphate buffer required about 4 atoms oxygen per mole of glycerol. As shown in Table 1, dihydroxyacetone (DHA) was also further oxidized in the Warburg flasks; approximately 3 atoms of oxygen were consumed per mole, which is consistent with the idea that glycerol is oxidized by a pathway which includes DHA as an intermediate. On the other hand, when the cells had been thoroughly washed with distilled water and separated by centrifuging at room temperature for 90 min, oxidation of glycerol stopped at 1 atom/mole, and activity toward DHA was reduced practically to zero. These activities were restored by the addition of diphosphopyridine nucleotide (DPN) up to a concentration of 10^{-4} *M*. Under the conditions used, DPN did not appear to be required either in the oxidation of glycerol to DHA or ethanol to acetic acid.

TABLE 1

OXIDATION OF GLYCEROL AND DHA BY RESTING *A. suboxydans* CELLS*

Substrate	Time of oxidation (min)	O_2 uptake (μatoms)	CO_2 produced (μmoles)
40 μmoles glycerol	300	150	47
40 " DHA	330	116	55

* The system contained 0.05 *M* phosphate, 0.01 *M* $MgCl_2$, and 10 mg (dry wt) of cold-washed cells per Warburg flask. Total volume = 2.8 ml; pH = 6.0; temp. = 29° C; air in gas phase. All values corrected for endogenous blanks.

The cold-washed cells showed retarded oxidation of glycerol in the later steps when no external phosphate was present, but this phenomenon was not observed in the case of ethanol oxidation or in the initial step of glycerol oxidation. The unusual nonparticipation of phosphate suggested that 2,4-dinitrophenol (DNP),

[1] A preliminary report was presented at the 12th International Congress of Pure and Applied Chemistry, New York, Sept. 1951. This work was supported by grants from the Nutrition Foundation, Inc., and from the Division of Research Grants and Fellowships, National Institutes of Health, USPHS. Published with the approval of the Monographs Publications Committee, Oregon State College, Research Paper No. 187, School of Science, Department of Chemistry.

[2] The authors wish to express thanks to L. A. Underkofler for a strain of *A. suboxydans*, and to Louis R. Hopping for technical assistance.

[3] ATCC strain Nos. 621 and 9322 were employed, as well as a strain of No. 621 given to us by L. A. Underkofler. The latter strain had been maintained in his laboratory since 1935.

[4] By acetylation (*13*) and by bound pantothenic acid assay (*14, 15*).

[5] Acetylation and citrate formation were performed in systems similar to those used by Kaplan and Lipmann (*13*) and Stern and Ochoa (*11*). The resting cell was employed as the enzyme.

TABLE 2

EFFECT OF DNP ON THE OXIDATION OF VARIOUS SUBSTRATES BY RESTING *A. suboxydans* CELLS*

Amt substrate (μmoles)	DNP concentration	Time of oxidation (min)	O_2 uptake (μatoms)
40 Glycerol	—	400	147
40 "	10^{-4} *M*	400	43
20 DHA	—	320	61
20 "	10^{-4} *M*	320	7
90 Ethanol	—	120	170
90 "	10^{-4} *M*	120	179
40 Sorbitol	—	450	158
40 "	10^{-4} *M*	450	53

* The system contained 0.05 *M* phosphate, 0.01 *M* $MgCl_2$, 10^{-4} *M* DPN and 10 mg (dry wt) of room temperature-washed cells per Warburg flask. Total volume = 2.8 ml; pH = 6.0; temp. = 29° C; air in gas phase. The substrate was tipped into the main compartment containing DNP after 5 min preincubation. All values corrected for endogenous blanks.

which is generally regarded as a phosphate "uncoupling" agent (*17, 18*), might affect only the reactions beyond DHA from glycerol. Representative data, summarized in Table 2, show this to be true. The first atom of oxygen was rapidly consumed in glycerol oxidation either in the presence or absence of DNP. However, after 1 atom of oxygen had been used, the reaction virtually ceased in the flasks containing 10^{-4} *M* DNP. With DHA, almost no oxidation occurred in the presence of DNP. Likewise, in the oxidation of sorbitol, DNP affected only the oxidation steps beyond sorbose, so that 1 atom of oxygen was utilized per mole. Ethanol oxidation, on the other hand, was completely unaffected by DNP.

The growth of *A. suboxydans*, either in glycerol or sorbitol media, was unaffected by DNP even at concentrations of the inhibitor up to 4×10^{-4} *M*. The results of some preliminary experiments showed that the filtrate of the fermentation liquor from a medium containing 5% sorbitol and 0.5% yeast extract had higher reducing power in the presence of DNP than in its absence, indicating an increased yield of sorbose. The above observations raise the question whether some of the energy storage mechanisms in this organism may differ from those in higher animals or other bacteria, in which coenzyme-linked energy-rich phosphate is regularly generated. Further details of these studies will be reported later.

References

1. KLUYVER, A. J., and DE LEEUW, F. J. G. *Tijdschr. Vergelijk. Geneesk.*, **10**, 170 (1924); KLUYVER, A. J. *The Chemical Activity of Microorganisms*. London: University of London Press (1931).
2. WIELAND, H., and BERTHO, A. *Ann. (Chem.)*, **467**, 95 (1928).
3. FULMER, E. I., and UNDERKOFLER, L. A. *Iowa State Coll. J. Sci.*, **21**, 251 (1947).
4. BUTLIN, K. R. *Dept. Sci. Ind. Research (Chem., Brit.), Special Rept. No. 2*, 1936.
5. VISSER'T HOOFT, F. Diss., Delft (1925).
6. HANN, R. M., TILDEN, E. B., and HUDSON, C. S. *J. Am. Chem. Soc.*, **60**, 1201 (1938).
7. KING, T. E., FELS, I. G., and CHELDELIN, V. H. *Ibid.*, **71**, 131 (1949).
8. NISHI, H., KING, T. E., and CHELDELIN, V. H. *J. Nutrition*, **41**, 279 (1950).
9. NOVELLI, G. D., FLYNN, R. M., and LIPMANN, F. *J. Biol. Chem.*, **177**, 493 (1949).
10. KING, T. E., and CHELDELIN, V. H. *Ibid.*, **174**, 273 (1948).
11. STERN, J. R., and OCHOA, S. *Ibid.*, **179**, 491 (1949).
12. NOVELLI, G. D., and LIPMANN, F. *Ibid.*, **182**, 213 (1950).
13. KAPLAN, N. O., and LIPMANN, F. *Ibid.*, **174**, 37 (1948).
14. NIELANDS, J. B., and STRONG, F. M. *Arch. Biochem.*, **19**, 287 (1948).
15. HOAG, E. H., SARETT, H. P., and CHELDELIN, V. H. *Ind. Eng. Chem., Anal. Ed.*, **17**, 60 (1945).
16. BUTLIN, K. R. *Biochem. J.*, **30**, 1870 (1936).
17. LOOMIS, W. F., and LIPMANN, F. *J. Biol. Chem.*, **173**, 807 (1948).
18. TEPLY, L. J. *Arch. Biochem.*, **24**, 383 (1949).

Manuscript received August 7, 1951.

The Absorption of Human Skin between 430 and 1,010 mμ for Black-Body Radiation at Various Color Temperatures

Raymond R. Heer, Jr.

Army Medical Research Laboratory, Fort Knox, Kentucky

It is an accepted premise that if dark and light skins are irradiated by the same source radiating in the visible and near infrared part of the spectrum the dark skin will absorb more than will the light skin. As far as the author can ascertain nothing has been published concerning the quantitative relations for the absorptance of skins of various colors. This paper is written to show the expected relative absorption of tanned and untanned white and Negro skin for the radiation between 430 and 1,010 mμ emanating from sources radiating at various color temperatures.

It is known that for black-body radiation at color temperatures less than 8×10^{3}° K there is no attenuation due to the transport of radiation through the atmosphere. As the color temperature of a source increases, the transmission coefficient for air decreases until, at 25,000° K, the transmission coefficient is approximately 0.4. Since the temperature of the ball of fire (which is considered to be a good approximation to a black-body radiator) resulting from the explosion of a nominal atomic bomb falls to 8×10^{3}° K in approximately 20 μsec when the radius of the ball of fire is thought to be about 8 yards (*1*) (a distance at which thermal radiation has not yet begun to play an important part), attention is not given to atmospheric attenuation. Neither is attention given to the fact that the flux density of the radiation varies with distance, nor that the type of day (clear or hazy) has an effect on the amount of radiation reaching a given point. The concern here is with the comparison of the maximum expected absorption of tanned and untanned skin of the white and Negro races. Although the ordinate of the accompanying graph is expressed in units of energy, it should be kept in mind that this energy is for the maximum expected absorption at the surface of the radiator and that no attempt has been made to calculate the energy arriving at a particular distance, as some authors have done.

The average absorptance values were calculated from average reflectance values obtained from indi-

vidual reflectance recordings of 113 subjects (71 white and 42 Negro). The reflectance curves were taken from three parts of the body: (*a*) a least-tanned spot (the inside of the right forearm midway between the wrist and the elbow), (*b*) a most-tanned spot (the outside of the left forearm midway between the wrist and the elbow), and (*c*) an average-tanned spot (the forehead over the left eye). The recordings were made on a G-E Recording Spectrophotometer operating on a range 431–1,000 mμ. The measurements were made in September in order to show as much difference as possible between the tanned and untanned skin areas.

If one considers what may happen to radiation falling on an object, it is apparent that the radiation may, generally speaking, be absorbed, reflected, or transmitted. Since 99% of the radiation which penetrates the skin is absorbed in the first 3 mm (*2*), and since the reflectance values are expressed in percentages, it can be assumed that 100 minus the reflectance, expressed as percentage, will give the percentage absorptance. This absorptance includes true absorption and scattering.

The absolute energy distribution for black-body radiators at various color temperatures from 2,000° K to 25,000° K (the range of temperature selected) for wavelengths from 440 to 1,000 mμ had to be determined. The energies from 440 to 720 mμ were calculated from Table 2B of *Misc. Pub. No. 56,* of the National Bureau of Standards (1925), at 20-mμ intervals. The energies from 700 to 1,000 mμ were calculated by use of the Planck formula

$$E = \frac{C_1 \lambda^{-5}}{\left(e^{(C_2/\lambda T)} - 1\right)},$$

where E = energy radiated in 1-mμ band width expressed in ergs/sec/cm²; $C_1 = 3.703 \times 10^{12}$; λ = wavelength expressed in mμ; e = base of the natural logarithms; $C_2 = 1.435 \times 10^7$ (440–720 mμ); $C_2 = 1.433 \times 10^7$ (700–1,000 mμ); and T = absolute temperature of the radiator (°K). Since the values of C_2 in the two sets of calculations were slightly different, the energies at 700 mμ and 720 mμ were calculated by both methods. It was found that the two methods had a percentage difference of less than 0.1%, a difference less than the possible error in the individual reflectance curves, the allowable error of the G-E Spectrophotometer being 0.5%.

The procedure for arriving at the amount of radiation absorbed from a radiator at a particular color temperature was as follows: One of the six sets of absorption data and a particular color temperature were chosen. The absorption at 440 mμ was multiplied by the energy at 440 mμ, the absorption at 460 mμ was multiplied by the energy at 460 mμ, etc.; finally, the absorption at 1,000 mμ was multiplied by the energy at 1,000 mμ. These products are the ordinates of a curve of expected energy absorption vs wavelength. It was not felt necessary to plot this curve, since interest was not in the energy absorption at a particular wavelength but in total absorption. The increment of wavelength was 20 mμ throughout. Therefore, the area under the curve was taken as:

$$20 \times \text{Ordinate}_{440} + 20 \times \text{Ordinate}_{460} + \ldots + 20 \times \text{Ordinate}_{1,000}$$

or

$$\text{AREA} = 20(\text{Ordinate}_{440} + \text{Ordinate}_{460} + \ldots + \text{Ordinate}_{1,000})$$

This area represents the total expected energy absorption for a particular type of skin which is exposed to a black body radiating at a particular color temperature.

It can be shown that the average percentage difference in total expected absorption for white average-tanned and most-tanned skin averages less than 2%, showing a maximum difference of 4.4% at 2,000° K. It can also be shown that the average percentage difference for Negro average-tanned and most-tanned skin is less than 1%, again the maximum difference (2.3%) being at 2,000° K. These percentage differences were considered small enough so that concern, henceforth, was with the tanned (forehead over left eye) and untanned (inside right forearm) parts of the body. None of the results applies explicitly to the most-tanned part of the body.

The comparison of the expected absorptions for white and/or Negro skin for any of the areas meas-

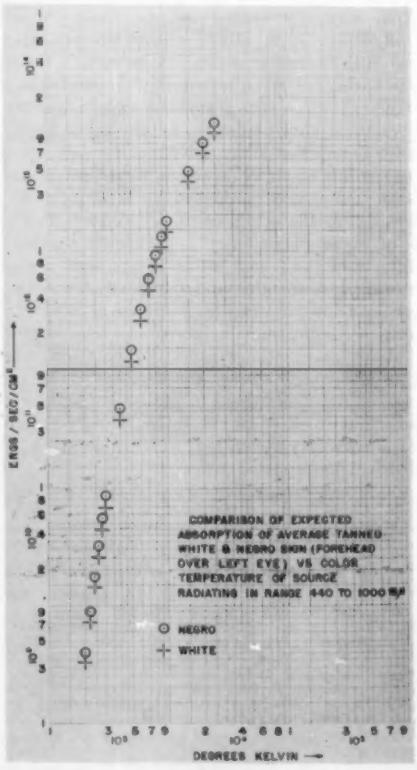

ERGS / SEC / CM²
COMPARISON OF EXPECTED ABSORPTION OF AVERAGE TANNED WHITE & NEGRO SKIN (FOREHEAD OVER LEFT EYE) VS COLOR TEMPERATURE OF SOURCE RADIATING IN RANGE 440 TO 1000 mμ
NEGRO
WHITE
DEGREES KELVIN

FIG. 1.

ured can be shown graphically. Fig. 1 shows the comparison of expected absorption for average-tanned Negro and average-tanned white skin. For example, at 4,000° K the total expected absorption for the average-tanned Negro skin is about 4.70×10^{11} ergs/sec/cm², and for the average-tanned white skin the total expected absorption is about 3.70×10^{11} ergs/sec/cm². Dividing the Negro value by the white value shows that we may expect approximately 27% more absorption for the tanned Negro than for the tanned white when they are both irradiated by a black body radiating at 4,000° K. Table 1 shows the ratio of expected absorptions for various skins being irradiated by radiators at various color temperatures.

TABLE 1

RATIO OF EXPECTED ABSORPTIONS OF AVERAGE TANNED AND UNTANNED WHITE AND NEGRO SKIN FOR VARIOUS COLOR TEMPERATURES

Color temperature	White forehead over left eye / White inside right forearm	Negro forehead over left eye / Negro inside right forearm	Negro inside right forearm / White inside right forearm	Negro forehead over left eye / White forehead over left eye	Negro forehead over left eye / White inside right forearm
2,000	1.15	1.10	1.27	1.22	1.39
2,200	1.15	1.09	1.29	1.23	1.41
2,400	1.15	1.09	1.31	1.24	1.43
2,600	1.15	1.09	1.32	1.25	1.44
2,800	1.15	1.09	1.34	1.26	1.45
3,000	1.15	1.09	1.34	1.27	1.46
4,000	1.15	1.08	1.37	1.27	1.47
5,000	1.16	1.07	1.37	1.27	1.47
6,000	1.16	1.07	1.36	1.25	1.46
7,000	1.16	1.06	1.36	1.25	1.45
8,000	1.16	1.06	1.36	1.24	1.44
9,000	1.16	1.06	1.36	1.24	1.44
10,000	1.16	1.06	1.35	1.24	1.43
15,000	1.16	1.05	1.34	1.22	1.41
20,000	1.16	1.05	1.34	1.22	1.41
25,000	1.15	1.05	1.34	1.22	1.40

Dividing the expected absorption of white tanned skin by the expected absorption of the white untanned skin showed that, for the color temperature range considered, the tanned skin would absorb 15–16% more energy than the untanned skin (Table 1). Applying the same procedure to the Negro showed the tanned skin would absorb an average of 7.2% more energy, varying from 10% more at 2,000° K to 5% more at 25,000° K. Comparing untanned Negro skin to untanned white skin, it was found that on the average the Negro would absorb 34% more energy than the white. This percentage increase was neither as constant nor as linear-appearing as the first two mentioned, starting at 27% at 2,000° K, increasing to 37% at 4,000° K, and then decreasing to 34% at 25,000° K. Comparing tanned Negro skin to tanned white skin, it was found that the Negro absorption would average 24% more than the white, varying from 22% at 2,000° K to 27% at 4,000° K, and then decreasing to 22% at 25,000° K. As the largest difference, it was found that the tanned Negro skin would average 44% more absorption than the untanned white skin, the variation going from 39% at 2,000° K, to 47% at 4,000° K, and back to 40% at 25,000° K.

TABLE 2*

EXPECTED RELATIVE ABSORPTIONS FOR AVERAGE UNTANNED AND TANNED WHITE AND NEGRO SKIN, TAKING RESPECTIVE ABSORPTIONS AT 2,000° K AS UNITY

Color temperature	White inside right forearm (Untanned)	White forehead over left eye (Tanned)	Negro inside right forearm (Untanned)	Negro forehead over left eye (Tanned)	Average
2,000	1.00	1.00	1.00	1.00	1.00
2,200	2.20	2.20	2.23	2.23	2.22
2,400	4.32	4.32	4.44	4.43	4.38
2,600	7.75	7.77	8.05	8.02	7.90
2,800	13.2	13.3	13.9	13.8	13.6
3,000	20.5	20.6	21.7	21.5	21.1
4,000	113.	114.	121.	119.	117.
5,000	346.	349.	372.	364.	358.
6,000	764.	770.	820.	798.	788.
7,000	1,380.	1,390.	1,480.	1,430.	1,420.
8,000	2,180.	2,200.	2,330.	2,260.	2,240.
9,000	3,160.	3,190.	3,370.	3,260.	3,240.
10,000	4,280.	4,320.	4,560.	4,390.	4,390.
15,000	11,500.	11,600.	12,100.	11,600.	11,700.
20,000	20,200.	20,300.	21,200.	20,400.	20,500.
25,000	29,600.	29,800.	31,100.	29,800.	30,100.

* The numbers in the table are quotients of expected energy absorption of skin being irradiated by various color temperature radiators divided by expected energy absorption of the same type skin being irradiated by a radiator at 2,000° K.

The increase of color temperature of the source necessary to produce a particular increase in absorption for white and Negro tanned and untanned skin was determined as follows: The expected absorption of each type of skin at each color temperature was divided by its expected absorption at 2,000° K. These values were then averaged, the over-all averages appearing as Column 6 in Table 2. It was found that the white averages varied from 0 to 3% below, and the Negro averages varied from 0 to 3% above, the over-all average. This slight difference is probably not significant from the standpoint of thermal radiation injury.

Taking the expected absorption for 2,000° K as unity, it was found that an increase of absorption by a factor of 10 could be expected for a radiator at 2,700° K, an increase of 10^2 for CT (color temperature) at 3,900° K, an increase of 10^3 for CT at 6,200° K, and an increase of 10^4 for CT at 14,000° K. It was noted, from the convexity of the graph in the direction of increase in energy, that the expected absorption increased more rapidly with an increase in CT in the region 2,000° K than it did in the region 25,000° K (*3*).

References

1. U. S. Los Alamos Scientific Laboratory. *The Effects of Atomic Weapons.* Washington, D. C.: GPO (1950).
2. HARDY, J. D., and MUSCHENHEIM, C. *J. Clin. Invest.*, **15**, 1 (1936).
3. HEER, R. R., JR. *Quantitative Studies on the Effects of Non-Ionizing Radiation on the Skin.* II. *The Absorption of Human Skin Between 440 and 1000 mμ for Black Body Radiation at Various Color Temperatures.* AMRL Report No. 6-64-12-08-(8) (11 May 1951).

Manuscript received August 8, 1951.

The Retention of a Discrimination

J. A. Dinsmoor[1]

Department of Psychology, Columbia University, New York

One of the earliest and most persistent problems in the functional analysis of the behavior of living organisms has been that of the retention or loss ("forgetting") of a learned performance over a period of time. There are, of course, a number of experimental operations that may be used to reduce the probability of a given action: these include, e.g., withholding the reinforcement for the act, changing the stimulus conditions, reducing the drive, or reinforcing competing behavior (including that which prevents aversive stimulation following upon the original act). But a special problem is posed by the observation that a deterioration occurs in the subject's performance with the passage of time even when no experimental operation is performed. This has led to the concept that time itself may be the pertinent variable at a psychological level of analysis. However, since the very existence of the organism during the interval between the successive tests implies the operation of certain relevant variables, it seems unlikely that the independent effect of the passage of time, if any, can be isolated and measured. The most that can be said is that when appropriate techniques are employed a substantial retention of simple motor acts over long periods of time may be demonstrated (*1–7*). Such findings, however, have not yet been extended in any clear fashion to the retention of a discrimination (i.e., an appropriate relationship between the probability of the act and the stimuli which have marked the occasions when it will be reinforced). This is the purpose of the present study.

Six white rats were put on a daily feeding rhythm which maintained them at approximately 85% of their body weight under *ad lib* feeding. A bar or lever was inserted into the experimental cage (*8*), and each depression of this bar was followed by the delivery of a 1/15-g pellet composed mainly of Purina laboratory chow. When the animals were conditioned, the discrimination training was begun by making the further receipt of food contingent upon the presence or absence of cage illumination from above (4.5 ft-c). Light and darkness were alternated in 5-min phases throughout daily sessions of 100 min each. Certain of the pressings in the light (S^D) were reinforced with food at irregular intervals (mean of 2 min); none of the pressings in the darkness (S^Δ) was reinforced. By the end of 16 such training sessions, 85–90% of all responses occurred during the light phase of the cycle. Seven further test sessions were then conducted that were identical in procedure save for a systematic manipulation of the hunger drive. The results of these tests, plus further details of apparatus and procedure, may be found in a separate paper (*9*).

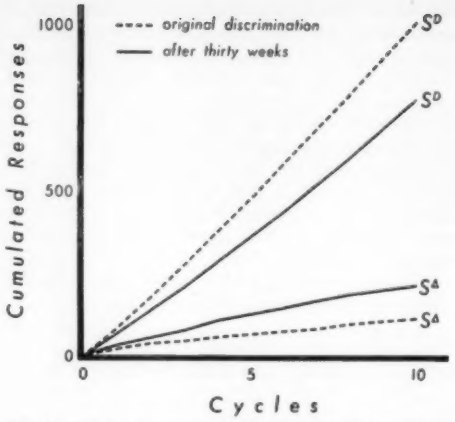


FIG. 1. The mean number of bar-pressings by 5 rats cumulated at the end of each 10-min cycle during a 100-min test session at the end of training and again 30 weeks later. The response was intermittently reinforced with food in the S^D (light phase of the cycle) but never in S^Δ (darkness).

In order to measure the retention of the discrimination over a period of time, all animals were brought back to 85% of normal body weight for an initial test session. One subject died during the ensuing period, but 30 weeks later the remaining 5 animals were tested a second time. To determine whether the rate of responding from cycle to cycle within either test period remained proportional to the total responding for the session, group means were calculated for each cycle. In both cases the rate of responding in S^D shows a slight increase (slope = 2.6 and 2.5 responses/cycle, respectively, by the method of least squares) and the rate in S^Δ a slight decline (−1.0 and −1.7) throughout the session. As may be seen in Fig. 1, however, where these means are cumulated for successive cycles, the shapes of the corresponding curves within either test session are approximately the same. It seems legitimate, therefore, to employ the totals for either session as measures of the animals' functioning before and after the retention interval.

Individual totals for each of the 5 animals are presented in Table 1. The typical effect of the passage of time is an increase in S^Δ responding (4 of 5 animals) and a decrease in S^D responding (all 5). The mean percentage of responding occurring in S^D drops from 89.9 on the first session to 80.3 on the second, a loss of 9.6 points. In view of the small number of subjects,

[1] Present address: Indiana University, Bloomington, Ind.

TABLE 1

Rat No.	Original discrimination			After 30 weeks		
	Responses		Percentage	Responses		Percentage
	(In S^D)	(In S^Δ)	(In S^D)	(In S^D)	(In S^Δ)	(In S^D)
12	1,242	125	90.9	1,027	154	87.0
13	1,094	167	86.8	827	265	75.7
14	1,070	87	92.5	913	348	72.4
15	700	107	86.7	341	35	90.7
17	977	80	92.4	804	261	75.5
Sum	5,083	566	.....	3,912	1,063	.....

however, and the range of individual variation, this figure should be viewed as no more than a rough estimate of any population value. The important feature to note is that a substantial difference in rates is retained by all animals. Similarly, the total number of responses drops from a mean of 1,130 to one of 995, or about 11.3%.

Although some loss of discrimination and some decline in total responding is suggested by these figures, it is concluded that a well-established discrimination between two stimuli may largely be retained over a period of 30 weeks, under normal laboratory conditions; the breakdown of such a discrimination is not inevitable with the mere passage of time.

References

1. Brogden, W. J. *Am. J. Psychol.*, **53**, 285 (1940).
2. Gagne, R. M. *J. Exptl. Psychol.*, **29**, 296 (1941).
3. Hunter, W. S. *Brit. J. Psychol.*, **26**, 135 (1935).
4. Kellog, W. N. and Wolf, I. S. *J. Exptl. Psychol.*, **24**, 366 (1939).
5. Skinner, B. F. *The Behavior of Organisms.* New York: Appleton-Century-Crofts (1938).
6. ———. *Psychol. Rev.*, **57**, 193 (1950).
7. Youtz, R. E. P. *J. Exptl. Psychol.*, **23**, 128 (1938).
8. Frick, F. C., Schoenfeld, W. N., and Keller, F. S. *Am. J. Psychol.*, **61**, 409 (1948).
9. Dinsmoor, J. A. *J. Abnorm. Soc. Psychol.* (In press).

Manuscript received June 18, 1951.

Effects of Indolebutyric Acid and Other Compounds on Virus Concentration in Plant Tissue Cultures

R. Kutsky[1]

Division of Plant Pathology,
University of California, Berkeley

In a previous paper by Kutsky and Rawlins (*1*), culture methods and a new method of analysis for tobacco mosaic virus in tobacco stem tissue cultures were described. It was reported that naphthalenacetic acid at 1.0 mg/l was effective in reducing the concentration of tobacco mosaic virus in tobacco stem tissue cultures. Further tests of compounds for effect on virus content are reported here.

The tissue culture technique and method of analysis were essentially the same as previously described (*1*). The characteristic nucleic acid absorption maximum at 260 mμ was used as a measure of virus concentration in processed extracts. By calculating the absorption ratio, T/C, of treated to control culture extracts one obtains an index of the effect of the added compound. For cultures where coloration was evident in the final fluid an added step—namely, precipitation of the virus in half-saturated ammonium sulfate and resuspension in water or $M/15$ phosphate buffer, pH 7, was inserted before the ultraviolet spectrophotometric analysis. Coloration, which occurred sporadically and interfered with the ultraviolet analysis, remained largely in the supernatant when the virus was precipitated with ammonium sulfate.

TABLE 1

Effect of Indolebutyric Acid on Concentration of Tobacco Mosaic Virus in Tobacco Tissue Cultures

Compound used	Concn (mg/l)	Terminal fresh wt of culture (mg)	Optical density/mg of tissue	T/C*	Av T/C
IBA	100	565	0.117	0.38	
Control	None	245	.306		
IBA	100	835	.144	.39	0.40
Control	None	315	.370		
IBA	100	590	.135	0.44	
Control	None	280	0.303		

* $\frac{T}{C} = \frac{\text{Optical density/mg treated tissue}}{\text{Optical density/mg control tissue}}$.

Twenty compounds were tested. The maximum concentration in each case is expressed as mg/l of solution brought to the pH of the medium (6.0) with 0.1 N sodium hydroxide: hydroxylamine, 1.0; sodium fluoride, 10; cobalt chloride ($CoCl_2 \cdot 6H_2O$), 10; zinc chloride, 100; uranyl acetate, 100; ascorbic acid, 100; desoxyribonucleic acid, 2,000; ribonucleic acid, 1,000; colchicine, 10; *p*-hydroxyphenylglycine, 10; D-usnic acid, 0.1; 2,6,diaminopurine, 0.01; terramycin, 100; streptomycin, 1.0; subtilin, 100; caprylic acid, 10; phenylacetic acid, 10; phenylpropionic acid, 100; phenylvaleric acid, 100; indolebutyric acid, 100.

The first 19 substances were found to have no effect on the virus content at the concentrations listed. In most cases the concentration given is close to the maximum that the tissues can tolerate and still exhibit normal growth. Lower concentrations of all compounds were tried, but it was found that the maximal effect, if any, was produced at the highest concentrations that the tissue cultures would tolerate.

Indolebutyric acid, like naphthalenacetic acid, is

[1] It is a pleasure to acknowledge the generous aid and advice given by T. E. Rawlins. The 2,6,diaminopurine was kindly given by R. L. Thompson, Department of Microbiology, Indiana University Medical School, and was supplied to him by G. H. Hitchings, Wellcome Research Laboratories. Terramycin was kindly supplied by Peter Ark. Subtilin was obtained through the courtesy of H. Humfeld, of the USDA Western Regional Research Laboratory. The D-usnic acid was generously supplied by J. C. Lewis, of the USDA Western Regional Research Laboratory. The phenylvaleric acid was synthesized by James Cason, of the University of California Department of Chemistry.

known to be active as a synthetic plant growth hormone (*2*). In two separate series of experiments it was found to be effective in reducing the virus concentration of the tissue cultures. The results of one series at 100 mg/l (Table 1) indicate an average ratio of T/C of 0.40. It was noted that the callus produced in the presence of indolebutyric acid (IBA) at 100 mg/l had a cinnamon-buff (Ridgway) appearance similar to that produced by naphthalenacetic acid at 1.0 mg/l. IBA was not tried at higher concentrations than 100 mg/l, but it was found to be similarly effective at 10 mg/l. At both concentrations it was noted that the terminal weight of the treated cultures was significantly higher than that of the control cultures. This would establish the growth-promoting property of IBA in mosaic-infected tobacco tissue cultures.

It is interesting to note that in contrast to naphthalenacetic acid and IBA, phenylacetic acid at 10 and 1.0 mg/l does not change the amount of virus present, although it is known to possess growth-promoting properties (*2*).

References

1. KUTSKY, R. J., and RAWLINS, T. E. *J. Bact.*, **60**, 763 (1950).
2. ZIMMERMAN, P. W., and WILCOXON, F. *Contribs. Boyce Thompson Inst.*, **7**, 209 (1935).

Manuscript received August 6, 1951.

A New Method for Detecting Penicillinase Production by Staphylococci

Abdel Aziz A. El Ghoroury[1]

Department of Bacteriology, Faculty of Medicine, Farouk I University, Alexandria, Egypt

Bondi, Spaulding, Smith, and Dietz (*1*) in 1947 described a method for rapid determination of susceptibility of infecting microorganisms to penicillin and other antibiotics. While using this method to study the incidence of penicillin-resistant staphylococcal infection in Farouk I University Hospital,[2] it has been found that it could also be used as a basis for a test to detect whether the strains studied produced penicillinase. Several other methods have been described for this purpose in recent years (*2–9*).

A blood agar plate that has already been dried in the incubator is uniformly streaked with a small loopful (using a loop 1 mm in diam) of a 24-hr broth culture of a known penicillin-sensitive strain of *Staphylococcus aureus*. With fine-pointed forceps sterilized in an alcohol flame, several sterilized filter paper disks (6.5 mm in diam) are individually dipped into a penicillin solution of 15 u/ml and then put on the streaked plate, at least 20 mm apart (after Bondi *et al.* [*1*]). One of the disks, which is given no further treatment, serves as a control, and its position is marked on the back of the plate. On each of the remaining disks a loopful of a 24-hr broth culture of one of the strains to be tested for penicillinase production is carefully placed, with appropriate identification on the back of the plate. In this way several strains are tested on one plate (usually 4 when using the ordinary 9-cm diam plates). A control disk is left in every plate used.

TABLE 1

Disk	Inhibition zone	Penicillinase production
Control	21 mm	
Strain A	Negative	Positive
Strain B	21 mm	Negative

The results are read after aerobic incubation of the plates at 37° C for 24 hr. Table 1 and Fig. 1 illustrate an experiment including one penicillinase-producing strain and one non-penicillinase-producing strain.

A zone of complete inhibition of growth of the streaked strain measuring over 20 mm in diameter is observed around the control disk. It is also present around the disk saturated with a culture of a non-penicillinase-producing strain. This is due to the inhibiting action of the penicillin, which is left intact in both conditions.

The disk saturated with a culture of a penicillinase-producing strain, on the other hand, is surrounded with very little or no inhibition. The streaked strain usually grows right to the disk, but often the growth is less marked in the immediate vicinity. The tested strain sometimes shows, beyond the rim of the disk, a concentric heavy growth which can easily be differentiated from the comparatively light streaked growth (Fig. 1). Presumably this is the result of destruction or inactivation of the penicillin by the enzyme produced by the tested strain.

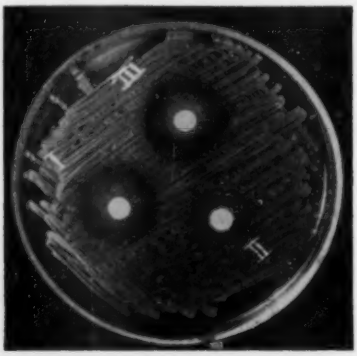


FIG. 1. I, growth inhibition around control disk; II, penicillinase positive test (no growth inhibition); III, penicillinase negative test (growth inhibition as control).

In some experiments, a second control was used by placing a loopful of sterile broth on one disk. But there was no difference between this and the previ-

[1] Thanks are due to M. M. Moussa, who prepared the photograph.

[2] This is the subject of another report.

ously described control, and its use was therefore discontinued.

Forty-four naturally penicillin-resistant strains and 39 penicillin-sensitive strains of coagulase-positive *Staph. aureus*, all of which were isolated from suppurative conditions and from nasal swabs, were tested for penicillinase production by this method. The results were clear-cut and reproducible. All strains of the former group were found positive, and all strains of the latter negative.

In parallel with this method, the same strains were tested by the cup method described by Bondi and Dietz (*3*), with slight modification. The results obtained by the two methods were in complete agreement.

References

1. Bondi, A., *et al. Am. J. Med. Sci.*, **213**, 221 (1947).
2. Kirby, W. M. M. *Science*, **99**, 452 (1944).
3. Bondi, A., and Dietz, C. C. *Proc. Soc. Exptl. Biol. Med.*, **56**, 132 (1944).
4. Spink, W. W., and Ferris, V. *Science*, **102**, 221 (1945).
5. Woodruff, H. B., and Foster, J. W. *J. Bact.*, **49**, 7 (1945).
6. Barber, M. *J. Path. Bact.*, **59**, 373 (1947).
7. Gilson, B. C., and Parker, R. F. *J. Bact.*, **55**, 801 (1948).
8. Waterworth, P. M. *Ann. inst. Pasteur*, **75**, 94 (1948).
9. Voureka, A., and Hughes, W. H. *Brit. Med. J.*, **1**, 393 (1949).

Manuscript received August 6, 1951.

The Decrease of Albumin Concentration of Human Blood Serum during Heat Inactivation

Peter Koets

Department of Obstetrics and Gynecology, Stanford University School of Medicine, San Francisco, California

Perusal of available literature fails to reveal a record of the consistent decrease of albumin content of human blood serum which occurs during heat inactivation.

In the following study, freshly obtained, undiluted blood serum was heated for 30 min at 56° C. Total protein and albumin concentrations, the latter after separation of globulins by Kingsley's modification of

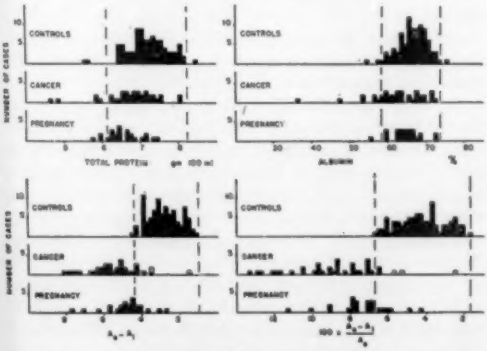


Fig. 1

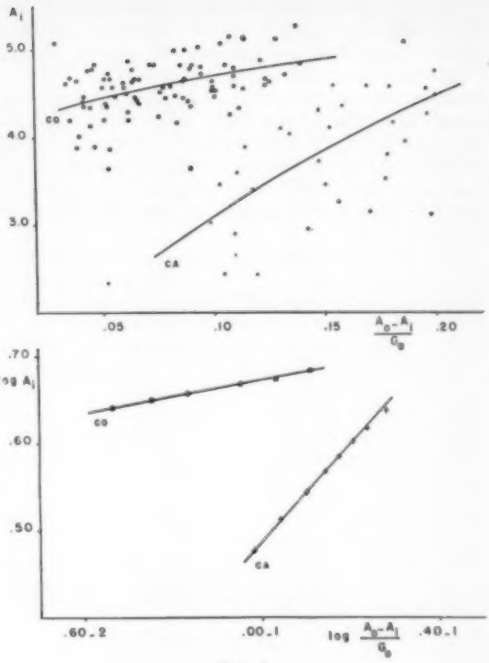


Fig. 2

Howe's procedure using 22.6% sodium sulfate at room temperature (*1*), were determined without delay in samples of the unheated and of the inactivated serum by means of the biuret color reaction (*2*).

The 92 "controls" were predominantly ambulant patients of the Gynecological Clinic. Excluded were patients who had had recent surgery or irradiation, those who were known to have fever, and those known to have a positive serum Wassermann reaction. Grouped separately were 37 cases of cancer involving cancer of the salivary gland, 1; esophagus, 1; stomach, 3; colon, 3; pancreas, 1; vulva, 1; vagina, 1; cervix uteri, 11; endometrium, 5; ovary, 2; breast, 4; skin, 3; and retroperitoneal sarcoma, 1. Also grouped separately were 24 pregnancy cases ranging from 10 weeks to term.

Fig. 1 represents the frequency distribution of total serum protein (mean value of "controls" 7.17 g/100 ml, standard deviation 0.53 g), of the albumin fraction of unheated serum (mean value of "controls" 65.7%, standard deviation 3.8%), and of the difference between the albumin fractions of unheated and of inactivated serum, $A_o - A_i$ (mean value of "controls" 2.75%, standard deviation 0.85%). Since serum albumin concentrations can vary greatly in pathological conditions, the decrease of albumin during inactivation was further expressed as a percentage value of the albumin fraction of unheated serum, $100\,\frac{A_o - A_i}{A_o}$ (mean value of "controls" 4.17%, standard

deviation 1.26%). Broken lines indicate values of the mean plus and minus twice the standard deviation. It is evident that the decrease of albumin during inactivation expressed as a percentage of the albumin fraction of unheated serum is significantly higher in cancer sera. The 5 cases where this ratio is found to be less than 6.7% were cancer of the skin (open squares), 3; cancer of the cervix, 1; cancer of the cervix *in situ*, 1. Under the described conditions the results obtained with pregnancy sera are similar to those of cancer.

The conclusion has been advanced from electrophoresis studies of normal horse serum that a "colloidal aggregation product" with an approximate mobility of β-globulin is formed during heat inactivation at the expense of the serum globulins and that if "produced in large amounts it adsorbed considerable quantities of albumin" (*3*). The decrease of albumin during heating of human serum may be due to adsorption of albumin on globulin after denaturation, the extent of the adsorption depending on the nature of the proteins in each particular condition. When the individual values of albumin concentration after inactivation are plotted against the ratio of albumin decrease to globulin (all values in g/100 ml) and curves of mean values are constructed (Fig. 2), a relationship can be demonstrated expressed by

$$\log A_i = .76 + .09 \log \frac{A_o - A_i}{G_o}$$ for the "controls," and by

$$\log A_i = 1.04 + .55 \log \frac{A_o - A_i}{G_o}$$ for cancer sera.

It may be anticipated that similar relationships can be established in other conditions where the serum proteins differ from the normal.

References

1. Kingsley, G. R. *J. Biol. Chem.*, **133**, 731 (1940).
2. Gornall, A. G., Bardawill, C. J., and David, M. M. *Ibid.*, **177**, 751 (1949).
3. Van der Scheer, J., Wyckoff, R. W. G., and Clarke, F. L. *J. Immunol.*, **40**, 39 (1941).

Manuscript received August 28, 1951.

Comments and Communications

Further Notes on Discrimination

Lorch *et al.* (Science, **114**, 161 [1951]) have brought before the scientific public a subject that is of great importance today. Discrimination in the United States against Negro citizens in all walks of life raises questions concerning our boast of democracy. Especially in science, where we commonly speak with enthusiasm and pride of the contributions of all nations to our disciplines, we should be alarmed at the fact that Negro citizens do not have equality with the rest of us when they desire to better mankind through science.

Ten years ago Lillie (Science, **95**, 10 [1941]), in his obituary for his student, Ernest Everett Just, said:

> An element of tragedy ran through all Just's scientific career due to the limitations imposed by being a Negro in America. . . . He felt this as a social stigma, and hence unjust to a scientist of his recognized standing. . . . That a man of his ability, scientific devotion, and of such strong loyalties as he gave and received, should have been warped in the land of his birth must remain a matter for regret.

It would seem desirable for more white American scientists to follow Dr. Lillie's lead in protest against discriminatory policies and practices, inasmuch as these are discouraging participation by Negroes in the fields of scientific research and teaching.

During the December 1950 meetings of the AAAS in Cleveland there was, so far as I am aware, no gross discrimination against Negro participants. There were, however, conspicuously few Negro delegates or speakers. The reasons for this are not far to seek:

1) Negroes who might otherwise develop a keen interest and a great ability in science often lack incentives to undergo expensive training when they realize that, after obtaining their training, they will either be forced into menial employment despite their abilities or will be employed in segregated schools whose limited budgets make for limited salaries, overloaded schedules, and lack of equipment or funds for research.

2) With individual exceptions the grade school and high-school training of Negroes is relatively inferior in most sections of the country, both in segregated schools for Negroes in the South and in unsegregated schools in the Negro districts of our Northern communities. This situation eliminates many Negro students from competition for college and university training at the same time that white students of equal or inferior basic capacity are able to complete their studies.

3) Because of mass discrimination in employment, Negro parents cannot afford to give their children the necessary scientific training.

4) Those Negroes who have succeeded in mastering all the hurdles and who have become science teachers and research workers, by and large are employed in low-paying positions and institutions, and cannot afford travel expenses to national meetings, nor can their institutions afford to pay their expenses.

Commonly we associate discrimination with our Southern states. Paradoxically, however, the majority of our Negro scientists are able to find employment only in the segregated schools of the South, with all that this implies. Such scientists, because of legal and extralegal restrictions, find themselves isolated in

large part from social and scientific contact with most of their fellow-scientists. On the other hand, the problem exists also in our Northern states. The chemist Percy Julian found his home bombed in Chicago. Recently, in the same city, Dr. Julian was barred from a luncheon of scientists at the Union League Club. Very few Northern universities and colleges have more than a token representation of Negroes on their faculties. Many schools, including medical schools, discriminate against Negro students through the so-called quota system.

Lorch *et al.* certainly are justified in complaining against discriminatory practices at a Nashville meeting of the southeast section of the Mathematical Association of America. Their suggestion that an antidiscrimination clause should be placed in the bylaws of that organization should be extended to cover all organizations of scientists. Furthermore, it would seem desirable for the AAAS and all its affiliated organizations to make concerted, though belated, efforts to break down some of the gross discriminatory practices that besmudge the training and hiring policies of most of our schools and laboratories, both in the South and in the North. In this manner the AAAS can better fulfill its function of serving scientists, both Negro and white. Perhaps a first step could be taken through the appointment of an interracial committee to make a thorough investigation of discrimination against American scientists. The committee thereupon could make specific proposals for appropriate action by the AAAS and its affiliates.

CHARLES C. DAVIS

Department of Biology, Western Reserve University

Limiting Factors

WHEN considering the principle of limiting factors, plant scientists still lean heavily on Blackman's concept (*Ann. Botany*, 19, 281 [1905]), which implies that, in a process influenced by several factors, only one (the one having the "slowest pace") can limit the process under a given set of conditions. The recent excellent textbook of Curtis and Clark (*Introduction to Plant Physiology*. New York: McGraw-Hill [1950]) presents two figures showing that increased photosynthetic yields can be obtained by increasing either CO_2 or light intensity within certain parts of their range, but when interpreting these data they say that the more obvious and more important reason for this phenomenon is that different parts of the test plants are under different environmental conditions. The implication is that Blackman's concept is correct, but that the failure of experimental conditions to insure uniform environment for all plant parts is responsible for the apparent discrepancy between experimental results and Blackman's diagram.

The fact is, however, that Blackman's diagram is oversimplified. This can be demonstrated by discussing the utilization of relatively "slow factors" in a process such as photosynthesis. Let us assume that all the

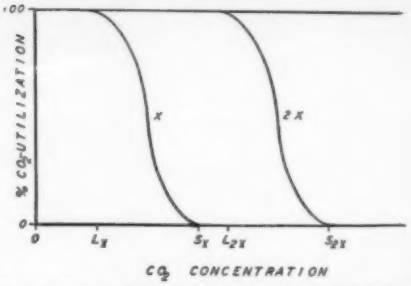


FIG. 1. Diagram of the relationship between CO_2-utilization and CO_2 concentration in photosynthesis, when light is held constant at a relatively low level.

factors in the photosynthetic process are relatively abundant, except CO_2 and light supplies. Let us give light the value x and allow CO_2 to vary between 0 and ∞; then give light the value $2x$ and again let CO_2 vary between 0 and ∞. A diagram of CO_2-utilization graphed against CO_2 concentration would then appear as shown in Fig. 1. Note that for any given light supply there are three ranges of CO_2 concentration: the range O–L, in which CO_2-utilization approaches 100%; the range L–S, in which CO_2-utilization decreases from near 100% to near 0%; and the range S–∞ in which CO_2-utilization approaches 0% asymptotically. In the range O–L utilization is so near complete that increased light supply does not increase yield detectably. In this range yield is linearly proportional to CO_2 supply. In the range S–∞ CO_2-utilization represents such a small fraction of the available supply that variation of the CO_2 supply has no detectable influence on yield. This is the "saturation" range. These two parts of the range were understood by Blackman, but he ignored the L–S range. Therein lay his oversimplification. In the L–S range CO_2-utilization is detectably less than 100%, and increase of other factors may provide higher efficiency of CO_2-utilization and higher yields; but CO_2-utilization in this range is detectably more than 0%, and so an additional CO_2 supply improves the availability detectably, and higher yields result. The relationship between CO_2 supply and yield, however, is not linear in this range.

Fig. 1 also illustrates the meaning of relative scarcity and relative abundance. With a light supply of x the CO_2 supply S_x represents approximate saturation. When light supply is $2x$, the CO_2 concentration L_{2x} represents relative scarcity, although the absolute value of L_{2x} is greater than S_x. It is obviously possible for several factors in a process such as photosynthesis to lie in an L–S range simultaneously. Under such conditions an increase in any one of these factors will provide detectable yield increases. The postulation of nonuniform environmental conditions is not needed to explain such a phenomenon.

JACOB VERDUIN

The Franz Theodore Stone Institute of Hydrobiology
The Ohio State University, Put-In-Bay

Book Reviews

Physical Geography. Arthur N. Strahler. New York: Wiley; London: Chapman & Hall, 1951. 442 pp. $6.00.

This text presents a thorough and refreshingly new approach to the study of physical geography. It has its faults, but they are far outweighed by the value of its concepts, excellent diagrams, maps and map exercises, and well-written textual material.

The first section, dealing with the earth in its space relations, is exceptionally well done. It goes far beyond the material covered in other texts to include such important matters as the tides and the phases of the moon.

Considering that it is the author's major field of interest, the second section—dealing with landforms—is a distinct disappointment. In contrast with the first part, it is superficial and suffers from both errors and omissions. In the glacial chapter, striae, ice polish, and *roches moutonnées* are not mentioned under alpine glaciation, making their appearance later in connection with the continental type. Unassorted deposits called "debris" in the paragraphs dealing with alpine ice, become "till" under continental glaciation. The actual term *roches moutonnées* is never used, although the form is discussed. The term "finger lake" is incorrectly applied to water bodies occupying troughs formed by alpine glaciers (p. 180), and the Finger Lakes of New York are attributed to blockage by glacial debris (p. 186), instead of being credited to glacial excavation. The statement that the porous nature of eskers prevents tree growth on them is incorrect—many eskers are wooded, including the one used as an illustration on the same page (p. 189). The definition of eskers should be expanded to include those formed in crevasses, or else the term "crevasse-filling" should be introduced. Similarly, few of the forms designated "kames" are "flat-topped landforms" built as deltas into lakes. The map exercises, associated with topographic maps reproduced in black and white, are well selected and excellently composed.

The third section, dealing with climate, includes a standard treatment of weather elements, illustrated with fine three-dimensional drawings. Here the author makes a real contribution to climatology in his proposal of a new type of climatic classification. In place of the present classifications based on vegetation (usually considered a good climatic indicator), Strahler proposes a grouping based on origin and controlling factors: air masses, their source regions, fronts, and movements. Characteristics of regions are described, but no attempt is made to draw boundaries for them. Three major groups are recognized: climates controlled by tropical air masses alone, by polar alone, and by both polar and tropical; 13 subtypes are recognized. The system is a real achievement, especially for the understanding of climates and the teaching of them to beginning students. It must not be expected, however, that it will replace Koeppen and Thornthwaite—for each has its own, distinct place.

This book will serve excellently as a text for a course in physical geography, conducted along rigorous scientific lines. It is the sort of book that adds prestige to geography in the eyes of our scientific colleagues. It goes straight and logically to the heart of the subject under consideration. There is no cluttering with unnecessary information—yet everything that is needed is there. It well serves the author's stated aim—to provide a sound scientific basis for future work, and to provoke in the student a greater interest and appreciation of his surroundings.

RICHARD F. LOGAN
Department of Geography
University of California, Los Angeles

Scientific Book Register

Araucanian Culture in Transition. Occasional contributions from the Museum of Anthropology of the University of Michigan, No. 15. Mischa Titiev. Ann Arbor: Univ. Michigan Press, 1951. 164 pp. and 17 plates. $2.50.

A Century of Technology, 1851–1951: A Symposium. Percy Dunsheath, Ed. New York: Roy Pub., 1951. 346 pp. $5.00.

Logic for Living: Lectures of 1921–22. Henry Horace Williams; Jane Ross Hammer, Ed. New York: Philosophical Library, 1951. 281 pp. $3.75.

Immuno-Catalysis and Related Fields of Bacteriology and Biochemistry. Rev. 2nd ed. M. G. Sevag. Springfield, Ill.: Thomas, 1951. 547 pp. $12.00.

A Century of Science, 1851–1951: A Symposium. Herbert Dingle, Ed. New York: Roy Pub., 1951. 338 pp. $4.75.

Fundamentals of Electronics. F. H. Mitchell. Cambridge, Mass.: Addison-Wesley, 1951. 243 pp. $4.50.

Essays on Archaeological Methods. Proceedings of a conference held under auspices of the Viking Fund. Anthropological Papers, Museum of Anthropology, University of Michigan, No. 8. James B. Griffin, Ed. Ann Arbor: Univ. Michigan Press, 1951. 151 pp. $1.50.

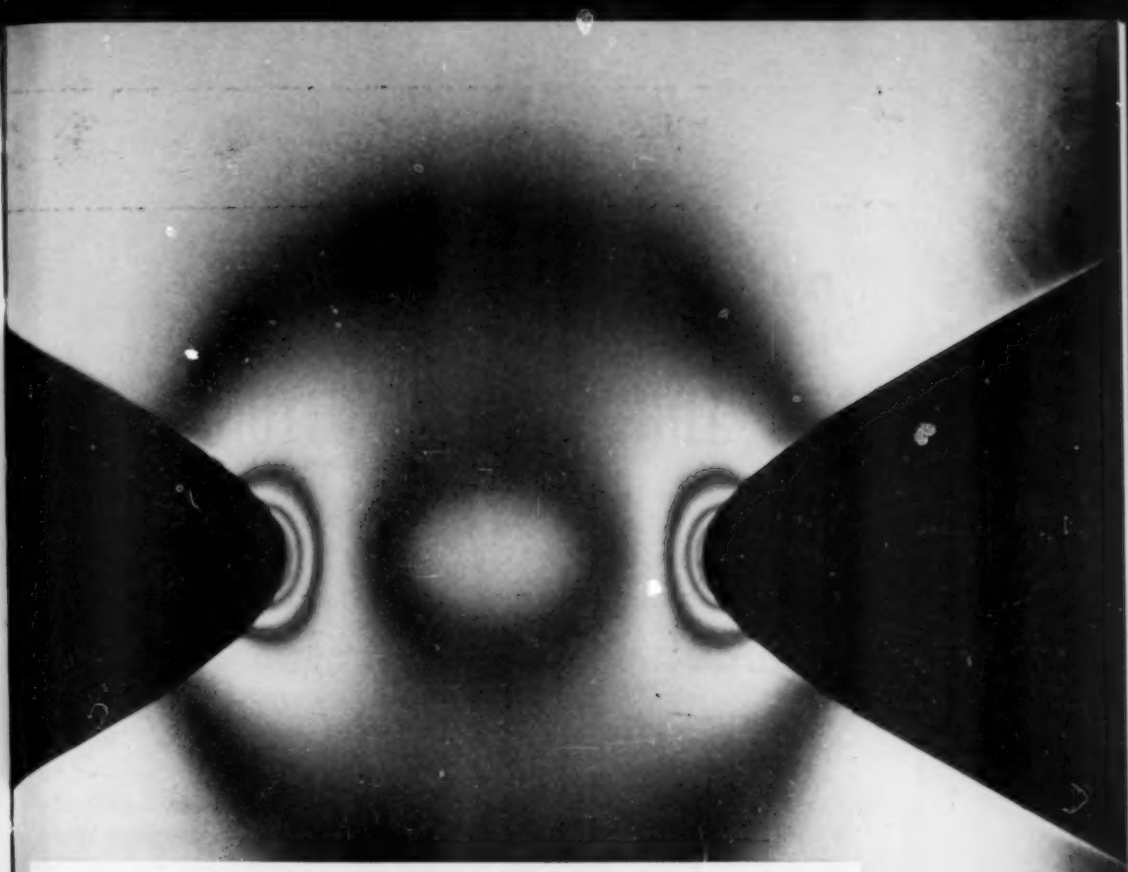
Einführung in die Theorie der Ausbreitung elektromagnetischer Wellen in Leitungen und Hohlkabeln. Hans Bomke and J. Gefahrt. Stuttgart: Wissenschaftliche Verlag, 1950. 163 pp.

Astronomy of Stellar Energy and Decay. Martin Johnson. New York: Dover, 1951. 216 pp. $3.50.

The Philosophy of the Enlightenment. Ernst Cassirer. Trans. from the German by Fritz C. A. Koellyn and James P. Pettegrove. Princeton, N. J.: Princeton Univ. Press, 1951. 366 pp. $6.00.

Biological Effects of External Beta Radiation. Raymond E. Zirkle, Ed. New York–London: McGraw-Hill, 1951. 242 pp. $3.25.

Renal Function. Transactions of the Second Conference, October 19–20, 1950, New York. Stanley E. Bradley, Ed. New York: Josiah Macy, Jr. Fdn., 1951. 178 pp. $3.00.



Photography sees what happens when you stretch a point

What you're looking at is a photograph of the stress patterns in a notched shaft that's being subjected to pure tension.

It's photoelastic stress analysis where polarized light is sent through plastic models of the part to be studied. Since some plastics become doubly refracting under stress, the image recorded on film reveals the character of the forces in the material. With white light and color film, the patterns of strain show variously colored striations and figures which indicate the magnitude of difference between the principal stresses.

Analysis of the photographic records of these patterns provides highly accurate data —solves problems that ordinarily might take weeks of tedious mathematical calculations. And the pictures can be filed for reference whenever needed.

Kodak makes the photographic materials for this and a host of other photorecording techniques. For the useful, detailed information you need on this practical process, your Kodak dealer has a new data booklet, "Photoelastic Stress Analysis." Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.

STRESS ANALYSIS

. . . an important function of photography

Photograph courtesy of Westinghouse Electric Corporation

Kodak
TRADE-MARK

new!

PITUITARY-ADRENAL FUNCTION

6 × 9 inches, illustrated, clothbound, 224 pages—$4.00
Price to AAAS members for prepaid orders—$3.50

PITUITARY-ADRENAL FUNCTION continues the AAAS tradition of presenting in book form the collected papers presented at symposium programs of wide interest. This volume includes 22 papers delivered at a two-day Symposium on the Adrenal Cortex at the AAAS meeting in New York City, December 1949.

PITUITARY-ADRENAL FUNCTION assembles important contributions of a score of laboratories in the United States and Canada from which many of the recent major advances in pituitary-adrenal physiology and therapeutics have come, and includes studies on the regulation of adrenal cortical activity, the role of the cortical hormones in protein, carbohydrate, and mineral metabolism, and effects of the cortical steroids and the ACTH in various disease states. A summary chapter on "Adrenolescence" by Dr. George Perera forecasts some of the possible future trends in this active field of endocrine research.

ORDER NOW

AAAS PUBLICATIONS • 1515 Mass. Ave., N.W., Washington 5, D. C.

Enclosed is $_____. Please Accept my order for_____ copy of PITUITARY-ADRENAL FUNCTION.

NAME _____
Please Print

STREET _____

CITY _____ **ZONE** _____ **STATE** _____

Aerodynamics

Astro-Physics

Chem. Engineering

Hydraulics

Mech. Engineering

Proceedings of the
Midwestern Conference
on

Fluid Dynamics

Volume 1
$10.00

May 12 and 13, 1950
University of Illinois

408 pages
5½ × 8½
cloth bound

J. W. EDWARDS
Lithoprinters
Ann Arbor, Michigan

DENTAL CARIES and FLUORINE

7½ x 10½, clothbound, double column, XI + 111 pages

FROM THE CONTENTS:

H. Trendley Dean	Epidemiological Studies in the United States
Robert Weaver	Epidemiological Studies in the British Isles and India
T. Ockerse	Fluorine and Dental Caries in South Africa
Philip Jay and Francis A. Arnold, Jr.	Epidemiological Aspects of Oral Lactobacillus Counts in Fluoride and Non-Fluoride Areas
Wallace D. Armstrong	Chemical Differences of Caries Susceptible and Immune Teeth and a Consideration of Food Sources of Fluorine
Harold C. Hodge and Reidar F. Sognnaes	Experimental Caries and a Discussion of the Mechanism of Caries Inhibition by Fluorine
F. J. McClure	Nondental Physiological Effects of Trace Quantities of Fluorine
B. G. Bibby	Topical Applications of Fluorides as a Method of Combatting Dental Caries
Francis A. Arnold, Jr.	The Possibility of Reducing Dental Caries by Increasing Fluoride Ingestion
Abel Wolman	Fluorine and the Public Water Supply

Published in 1946, this volume is attracting increasing attention today. $3.50—Cash order price to AAAS members $3.00

ORDER NOW

TO: AAAS, 1515 Mass. Ave., N.W.
Washington 5, D. C.

Enclosed is $..... Please accept my order for
..... DENTAL CARIES AND FLUORINE

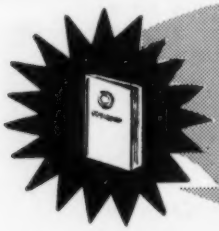
Name .....
Address .....
City ..... Zone ..... State .....

Will serve you well—as they have served thousands of biologists throughout the world for over thirty years. The importance of these items to human welfare far transcends their monetary value and The Coleman & Bell Company appreciates this responsibility by producing biological stains that are always *dependable*. All of the stains in common use have been tested by the Biological Stain Commission.

C & B Products are distributed by
Laboratory and Physician Supply Houses
Throughout the World

Catalog Upon Request. THE COLEMAN & BELL Co., Inc.
Manufacturing Chemists, Norwood, O., U.S.A.

COLEMAN & BELL



ONE BOOK MAY BE PRICELESS TO YOU

Over 140 foreign periodicals . . . over 700 foreign book reprints . . . ready for delivery at prices even lower than the original through the Edwards Brothers LITHOPRINT process of Book REPRINT.

Here's your opportunity to have access to the great discoveries and advances of the War Years in Europe.

One book may be priceless to you!

SEND FREE CATALOGUES AT ONCE TO

NAME_____

STREET_____

CITY_____ STATE_____

J. W. EDWARDS
ANN ARBOR, MICHIGAN

Publications Received

Abridged Scientific Publications from the Kodak Research Laboratories, Vol. 31, 1949. Rochester, N. Y.: Eastman Kodak Company, 1951. 478 pp.

Baltimore in Export Trade, Vol. 5, No. 2. Studies in Business and Economics. College Park: Univ. Maryland, Bur. Business and Econ. Research, Sept. 1951.

A Bibliography on "The Effects of X-Ray on Bacteria," (1896 to August 1951). Radcliffe F. Robinson, Michael D. Phillips, and Margaret G. Nagelsen. Columbus, Ohio: Battelle Memorial Institute, August 1951.

Een Bijdrage tot de Economische Betekenis van het Energieverbruik. E. H. F. Van Der Lely. Wassenaar, The Netherlands: Uitgever, Drukkerij Werner.

The Biochemistry of Fertilization and the Gametes. Biochemical Society Symposia No. 7. R. T. Williams, Ed. Cambridge, Eng.: University Press, Sept. 1951. 9s. 6d.

A Citizen's Handbook of Sexual Abnormalities. Samuel W. Hartwell. Washington: Public Affairs Press, 1951. 71 pp. $1.00.

The Climate of Blue Hill According to Air Masses and Winds. Photos P. Karapiperis. Harvard Meteorological Studies No. 9. Cambridge, Mass.: Harvard Univ. Press, 1951. 105 pp. $1.25.

Conference on the Origin and Constitution of Coal. Conference held at Crystal Cliffs, Nova Scotia, June 21–23, 1950. Halifax: Nova Scotia Dept. Mines, Nova Scotia Research Foundation, 1950.

Co-ordinating Committee on Abstracting and Indexing in the Medical and Biological Sciences. Report on meetings and activities through 1949. Paris: Unesco. (U. S. distributor: Columbia Univ. Press, 2960 Broadway, New York 27.) 92 pp. 85¢.

Deficiency Diseases in Japanese Prison Camps. Medical Research Council Special Report Series No. 274. Dean A. Smith and Michael F. A. Woodruff. London: HM Stationery Off., 1951. 209 pp., 5 plates. 6s. 6d.

Disposal of Chemical Waste at Sea. Report of Committee for Investigation of Waste Disposal. Alfred C. Redfield and Lionel A. Walford. Pub. No. 201. Washington, D. C.: NRC, National Academy of Sciences, 1951. 49 pp. $1.00.

Electric Power and Social Policy. William H. Connor *et al.* New York: Teachers College, Columbia University, 1951. vi + 53 pp. 75¢.

Essays on Archaeological Methods. No. 8. Proceedings of a conference held in New York March 1950. James B. Griffin, Ed. Ann Arbor: Museum of Anthropology, Univ. Michigan. 1951. 151 pp. $1.50.

Ex America. Garet Garrett. Caldwell, Idaho: Caxton Printers, 1951. 42 pp. 75¢.

Facing the Facts about Cancer. Rev. ed. Dallas Johnson, for Am. Cancer Soc. and Natl. Cancer Inst., USPHS. New York: Public Affairs Pamphlets No. 38, 1951. 20¢.

Fifth Annual Report for the Year Ending June 30, 1951. Oak Ridge, Tenn.: Oak Ridge Inst. Nuclear Studies, 1951.

First Annual Report, 1950–1951. New York: Natl. Assoc. Mental Health, Nov. 1951.

Forty-First Biennial Report of the Division of Fish and Game for the Years 1948–1950. Warren T. Hannum, director. State of California: Dept. Nat. Resources, 1951. 143 pp.

The General Science Handbook, Pt. I. Albany: N. Y. State Education Dept., 1951.

DISTINGUISHED COLLEGE SCIENCE TEXTS

THE PRINCIPLES OF HEREDITY
FOURTH EDITION
By LAURENCE H. SNYDER

THE BIOLOGY OF BACTERIA
THIRD EDITION
An Introduction to General Microbiology
By ARTHUR T. HENRICI and ERLING J. ORDAL

GENETICS AND THE RACES OF MAN
An Introduction to Modern Physical Anthropology
By WILLIAM C. BOYD

AN INTRODUCTION TO THE ANATOMY OF SEED PLANTS
By ERNEST L. STOVER

D. C. HEATH AND COMPANY
Sales Offices: New York, Chicago, Atlanta, San Francisco, Dallas
Home Office: Boston

THE RICKETTSIAL DISEASES OF MAN

This symposium volume is a comprehensive survey of the general field of Rickettsial diseases in man. Among the contributors appear the names of many of the foremost American authorities on this important and relatively new field of medicine.

The first group of papers includes discussions of the taxonomy, biology, isolation, and identification of vectors, and reservoirs of infection of the Rickettsial diseases of man. The second group of papers is devoted to discussions of serological reactions, the Weil-Felix reaction, the complement-fixation and agglutination reactions, and the preparation and standardization of Rickettsial vaccines. The final group of papers treats of insecticides, methods of their application, and mite controls.

Many of the 27 contributors to this volume during World War II were on the battle fronts in Africa, Italy, France and Germany, protecting our troops and the local populations wherever Rickettsial diseases prevailed. Rarely, if ever, have the authors of a medical book had so wide and so successful practical experience in the very subjects on which they have written.

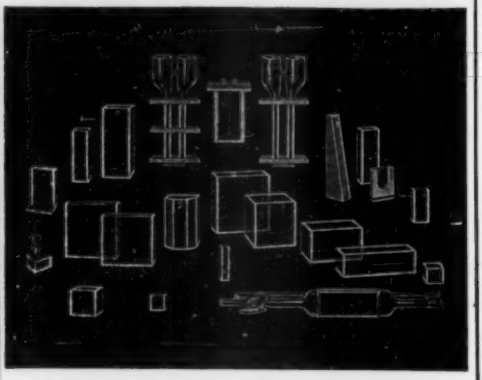
ORDER YOUR COPY NOW

To: A.A.A.S. Publications
1515 Massachusetts Avenue, N.W., Washington 5, D. C.

Please accept my order for one copy of *The Rickettsial Diseases of Man* (7¼ × 10¼, cloth bound). My check in correct payment is enclosed ($5.25 to A.A.A.S. members, $6.25 to those who are not members; including postage.)

Name .....
Address .....
City ..... Zone ..... State .....

GLASS ABSORPTION CELLS made by ***KLETT***



Makers of Complete Electrophoresus Apparatus

SCIENTIFIC APPARATUS

Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

RESEARCH BIOCHEMICALS
for
Biochemical
Biological and Microbiological
INVESTIGATIONS

WRITE FOR

NEW CATALOGUE

#S 950

Listing over 500 Important Biochemicals

NUTRITIONAL BIOCHEMICALS CORP.
CLEVELAND 28, OHIO

Meetings & Conferences

Jan. 13–15. American College of Clinic Administrators. Conrad Hilton Hotel, Chicago.

Jan. 14–18. Society of Automotive Engineers (Annual). Hotel Book-Cadillac, Detroit.

Jan. 15–18. Highway Research Board (Annual). National Academy of Sciences and National Research Council, Washington, D. C.

Jan. 16–18. Society of Plastics Engineers (Annual). Chicago.

Jan. 18–19. Congress on Industrial Health. Hotel William Penn, Pittsburgh.

Jan. 20–24. Pan American Congress of Otorhinolaryngology and Bronchoesophagogology. Havana.

Jan. 21–22. Compressed Gas Association (Annual). Waldorf-Astoria, New York.

Jan. 21–22. Josiah Macy, Jr. Foundation Conference on Blood Clotting. Cornell University, Ithaca, N. Y.

Jan. 21–25. American Institute of Electrical Engineers (Winter). Hotel Statler, New York.

Jan. 26. Metropolitan Detroit Science Club, Wayne University, and Institute for Economic Education. Institute and Industrial Exhibits on "Jobs Open to Science Trained High School Graduates." Wayne University, Detroit.

Jan. 28–31. Symposium on Modern Methods of Analytical Chemistry (Annual). Louisiana State University, Baton Rouge.

Jan. 29–31. American Meteorological Society. Roosevelt Hotel, New York.

Jan. 31–Feb. 1. American Society for Metals (Midwinter Technical). William Penn Hotel, Pittsburgh.

Jan. 31–Feb. 2. American Physical Society (Annual). Columbia University, New York.

Feb. 1–2. Protein Conference (Annual). Bureau of Biological Research, Rutgers University, New Brunswick, N. J.

Feb. 3–8. American Society for Testing Materials. The Shoreham, Washington, D. C.

Fef. 15–16. Mathematical Association of America (Louisiana-Mississippi Section). Northwestern State College, Natchitoches, La.

Feb. 17–24. Brotherhood Week.

Feb. 18–Mar. 7. British Commonwealth Scientific Official Conference. Canberra and Melbourne, Australia.

Feb. 25. Massachusetts Society for Research in Psychiatry. Cushing Hospital, Framingham.

Feb. 28–Mar. 1. National Conference on Rural Health. Shirley-Savoy Hotel, Denver.

Mar. 3–5. National Cancer Conference. Netherland Plaza Hotel, Cincinnati.

Mar. 3–7. American Society for Testing Materials (Spring). Cleveland.

Mar. 6–8. American Academy of Forensic Sciences (Annual). Biltmore Hotel, Atlanta, Ga.

Mar. 10–14. National Association of Corrosion Engineers (Annual). Galveston.

Mar. 16–19. American Institute of Chemical Engineers. Atlanta Biltmore Hotel, Atlanta.

Mar. 17–19. Midwestern Conference on Fluid Mechanics. Ohio State University, Columbus.

Mar. 17–22. Pakistan Association for the Advancement of Science (Annual). Peshawar University, N.W.F.P.

Mar. 19–21. American Association of Anatomists (Annual). Brown University, Providence, R. I.

Bring your set of AAAS DIRECTORIES up-to-date with the NEW

CENTENARY SUPPLEMENT

6 × 9 in., clothbound, 392 pages—$5.50; to AAAS members for prepaid orders—**$4.75**

Combination offer:

If you don't already have a copy of the AAAS PROCEEDINGS AND DIRECTORY OF MEMBERS 1940–1948, take advantage of this special combination offer—

AAAS PROCEEDINGS AND DIRECTORY OF MEMBERS 1940–48
6 × 9, clothbound, 1218 pages, October 1948

and the NEW

CENTENARY SUPPLEMENT—Both volumes in one order—$10.50
Price to AAAS members for prepaid orders—$8.50

Here's what you receive:

- A general directory giving the usual biographical sketch of each of the 13,000 scientists who joined the AAAS in 1948. Information including addresses as of *June 1950*, year of birth, highest degree and institution, specialty and professional connection, year of AAAS membership and fellowship, and sectional affiliation.
- A geographical index giving these names arranged by countries, states, cities, indicating field of interest.
- Detailed information on the 1948 meetings and officers.
- Another 40,000 names in the 1940–1948 volume, published October 1948.
- Preceding the Directory of Members in the 1940–48 volume is a history of the Association from its founding in 1848 to 1948, and a summary of the organization, objects, classes of members, numbers of members, dues, journals, awards, etc., of each of the 203 societies that were affiliated and associated with the AAAS in 1948.

The combined volumes offer an invaluable directory and a compact survey of organized American science from its earliest days to the present time . . . making an outstanding addition to your library.

ORDER NOW

AAAS PUBLICATIONS • 1515 Mass. Ave., N.W., Washington 5, D. C.

Enclosed is $..... **Please accept my order for:**
☐ **COMBINATION OFFER** ☐ **CENTENARY SUPPLEMENT only**

NAME_____
Please Print

STREET_____

CITY_____ **ZONE**_____ **STATE**_____

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries—at a very low cost

CLASSIFIED: 15¢ per word, minimum charge $3.00. Use of Box Number counts as 10 additional words.

DISPLAY: $17.50 per inch, no charge for Box Number.

Correct payment to SCIENCE must accompany all ads. Insertion usually made 2 or 3 weeks after receipt of ad.

SCIENCE • 1515 Mass. Ave., N.W., Wash. 5, D. C.

POSITIONS WANTED

Bacteriologist: Ph.D., postdoctoral research fellow. Experienced in bacterial physiology and animal experimentation. Publications. Desires research or teaching-research position. Box 59, SCIENCE. X

Ecologist, known also as phytogeographer and plant taxonomist, 42, Ph.D., D.Sc., distinguished in research and exploration (more than 100 publications including books, numerous scientific expeditions, Who's Who in America, etc.), many years' teaching and administrative experience in ancient and famous university, also editing, languages, interviewing, planning and organizing, fellow or member numerous learned societies, desires headship department giving due scope, of institution, or college from 1952 or 1953, meanwhile available for ecological course in N.E. or few more speaking engagements. Box 53, SCIENCE. X

Position Wanted:
Directorship or assistant directorship of research, directorship of technical development or academic post; eight years' teaching experience (bacteriology); four years, research bacteriologist and three years, development bacteriology, pharmaceutical industry; for further information please write Science Division, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Writer, Editor, medicine, biology; physical science. Age 37. Teaching, laboratory experience. Competent journalist. West. Box 61, SCIENCE. X

POSITIONS OPEN

Microbiologist with interest in metabolism of micro-organisms. Sound biochemical training and knowledge of growing of micro-organisms; for top position in new research institute in Mexico City. Reply Chemical Specialties Co., Inc., 22 E. 40th St., New York 16, N. Y., giving biographical description, including references. X

Literature Scientist—for literature research in clinical and preclinical fields with well-established Philadelphia pharmaceutical manufacturer. At least M.S. or equivalent experience, chemical-biological background, preferably pre-medical training, some experience in scientific literature searching. Liberal employee benefits, excellent working conditions and facilities. Salary open. Send complete details. Box 62, SCIENCE. X

YOU can TELL and SELL over 32,000 top scientists here . . . at a very low cost.

Your sales message in an ad this size costs only $43.75 at the one-time rate—less for multiple insertions. And the results!—well, here's what one of the many satisfied advertisers in SCIENCE has to say . . .

"SCIENCE is consistently our most profitable medium. Business secured solely thru SCIENCE ads has been the backbone of our success in this field."

"We carry a considerable amount of advertising in various periodicals, but none is so productive of results as SCIENCE."

Prove to yourself the effectiveness of SCIENCE in increasing your Market, Sales, and PROFITS—send your "Copy" NOW —or write for further information and Rate card No. 27B.

SCIENCE *weekly reaches over 32,000 top scientists* 1515 Mass. Ave., N.W., Wash. 5, D. C.

POSITIONS OPEN

Microtechnician-Zoologist. Ph.D. preferred, head microscope slides department. Large Biological Supply Concern. Familiarity with modern techniques essential. Position involves production, supervision of staff, development. Responsible position with excellent future. Box 60, SCIENCE. 1/11, 1/18

Positions Open:
(a) **Bacteriologist,** Ph.D., trained in virology and, also, biochemist well grounded in intermediary metabolism, enzymes, hormone and cancer research; one of major companies; straight research. (b) **Chemist,** Ph.D., trained in protein chemistry preferably with minimum three years' experience; industrial research; large city, university medical center; Midwest; $6000–$8000. (c) **Pharmacologist** to divide time directing research division, pharmaceutical company and serving as professor pharmacology in medical college; Ph.D. or M.D.; competent administrator with teaching ability required. (d) **Medical Bacteriologist;** M. S. or Ph.D.; research and development; around $5,000; Chicago. (e) **Biochemist** with practical training in physiological chemistry and toxicology; Ph.D. preferred; fairly large hospital; Pacific Coast. (f) **Ph.D.,** primarily trained in physical chemistry and thermodynamics; advantageous if oriented in direction of biophysics; medical school research appointment; Midwest. S1-1 Science Division, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Wanted—Technician for research laboratory. Must have working knowledge of electrophysiology apparatus, electronics, and machine tools. Address Box 730, Kirksville, Missouri. 1/11

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries—at a very low cost

CLASSIFIED: 20¢ per word, minimum charge $5.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —providing satisfactory credit is established.

Single insertion	**$17.50 per inch**
7 times in 1 year	**16.00 per inch**
13 times in 1 year	**14.00 per inch**
26 times in 1 year	**12.50 per inch**
52 times in 1 year	**11.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

LANGUAGES

Listen and Learn a Language by LINGUAPHONE

At home learn to speak Spanish, French, German, Russian, the Asiatic languages by quick easy Linguaphone World's-Standard **Conversational** Method. Save time, work, money. Over a million Home-study students. *Send for* **free** *book* **today.**

LINGUAPHONE INSTITUTE • 8401 Radio City, New York 20

BOOKS

WANTED TO PURCHASE . . . **SCIENTIFIC PERIODICALS and BOOKS** Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted.

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC. Boston 19, Massachusetts

SCIENTIFIC BOOKS and PERIODICALS WANTED
Complete libraries—Sets and runs—Single titles
Also, please send us your want lists.
STECHERT-HAFNER, INC.
31 East 10th St., New York 3

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries—at a very low cost

CLASSIFIED: 20¢ per word, minimum charge $5.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

Single insertion	$17.50 per inch
7 times in 1 year	16.00 per inch
13 times in 1 year	14.00 per inch
26 times in 1 year	12.50 per inch
52 times in 1 year	11.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

PROFESSIONAL SERVICES

Since 1885
ALBERT TEACHERS AGENCY and COLLEGE BUREAU

A NATIONAL SERVICE

•

RELIABLE and PERSONAL SERVICE

. . . to Colleges and Universities of the Nation and their Personnel. Originated and continued by Three Generations of The Albert Family.

Member N.A.T.A.

25 E. Jackson Blvd. Chicago 4, Illinois

LOOKING FOR A PUBLISHER?

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome.

VANTAGE PRESS, Inc. 230 W. 41 St., New York 18.

FOOD RESEARCH LABORATORIES, INC.

Founded 1922

Philip B. Hawk, Ph.D., President
Bernard L. Oser, Ph.D., Director

Research • Analyses • Consultation

Biological, Nutritional, Toxicological Studies for the Food, Drug and Allied Industries

48-14 33rd Street, Long Island City 1, N.Y.

• RESEARCH
• CONSULTATION
• ANALYSES

SUPPLIES AND EQUIPMENT

All Amino Acids (natural, synthetic, unnatural), Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.

BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.

new HEINICKE micro illuminator

Designed by Dr. Kurt J. Heinicke, for the inclined binocular microscope—superb at all magnification levels. 3" clear, aspheric condensing system. Equal or better than $60.00 illuminators. Price $9.50. Please order directly or write for details.

HEINICKE Instrument Corporation

• P. O. BOX 2872 HOLLYWOOD, FLORIDA

SUPPLIES AND EQUIPMENT

FOR MICROSCOPY—SHILLABER'S IMMERSION OIL

Numerous advantages over Cedar Oil. Used in many leading laboratories.

Type A (low viscosity)—preferred by many.
Type B—regular viscosity

COMBINATION PACKET (1 oz of each type) $1

Stock bottles: 4 oz $1.50 1 lb. $4

Order from your dealer or write us for descriptive leaflet IMO—

R. P. CARGILLE 118 Liberty St., New York 6, N. Y.

BASIC MANUFACTURERS

of analytically pure L-ISOLEUCINE, GLYCLYGLYCINE, L-PROLINE, HYDROXY-L-PROLINE, L-ARGININE · HCl and other AMINO ACIDS

PREMIXED MEDIA FOR MICROBIOLOGICAL ASSAY of AMINO ACIDS

Send for our catalogue

H. M. CHEMICAL COMPANY, LTD.
1651—18th St. Santa Monica, Calif.

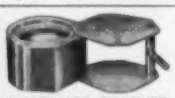
AVOID DELAY . . . . *Cash in Advance payment* MUST be enclosed with ALL classified ads. *See "Charges and Requirements"*

• HYPOPHYSECTOMIZED RATS

Shipped to all points via Air Express
For further information write

HORMONE ASSAY LABORATORIES, Inc. • 808 E. 58th St. Chicago 37, Ill.

Fine Organics Prepared. Will prepare rare or semi-rare organic compounds in 1 lb. to 5 lb. lots. Rapid service, Reasonable prices. Henry Hastie, 5 Grand St., Oneonta, N. Y. 1/11



HASTINGS TRIPLET
10X—$12.00
Ramsden Doublet
10X— 6.00

FOR BRUTE SERVICE—
THIS LENS TEAM CAN'T FAIL!

Stainless steel, solvent & heat-resisting cement, flawless optics, guarantee lifetime durability. Choice of field, life, physical scientists and educators everywhere.

Literature available: magnifiers, ultraviolet & radiation equipment, scalers, geology & forestry material, drafting furniture.

STRATEX INSTRUMENT CO. Mfrs. Exclusively for SCIENTISTS
1861 HILLHURST AVE., LOS ANGELES 27, CALIF. U.S.A.

STAINS
STARKMAN Biological Laboratory

• RARE
• COMMON
Price list on Request
• 461 Bloor St., W. Toronto, Canada

Are YOU seeking . . .

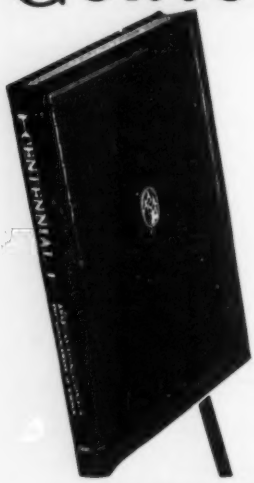
a new position, or new personnel?

41 replies received from ONE classified ad in SCIENCE . . . Your ad here will get results!

Send your ad NOW!

Enrich your library with the scientific and historic value of this unique volume

Centennial



7½ x 10¼ inches, double column, clothbound, 320 pages

Symposia presented to commemorate the first hundred years of AAAS include 42 papers by leading scientists in thirteen major fields:

- Sciences of Society
- Educational Potentials
- Human Individuality
- Food and Nutrition
- Housing
- World Health Problems
- Sources of Energy
- The Upper Atmosphere
- The World's Natural Resources
- Genes and Cytoplasm
- High Polymers
- Interactions of Matter and Radiation
- Waves and Rhythms

● Cash price to AAAS members $4.50
Nonmembers and institutions $5.00

ORDER NOW

A.A.A.S. Publications
1515 Massachusetts Ave., N.W.
Washington 5, D. C.

Enclosed find my check or money order in the amount of $..... for ..... copy of *Centennial*.

NAME .....
ADDRESS .....
CITY ..... ZONE .... STATE .....

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries—at a very low cost

CLASSIFIED: 20¢ per word, minimum charge $5.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —providing satisfactory credit is established.

Single insertion	$17.50 per inch
7 times in 1 year	16.00 per inch
13 times in 1 year	14.00 per inch
26 times in 1 year	12.50 per inch
52 times in 1 year	11.00 per inch

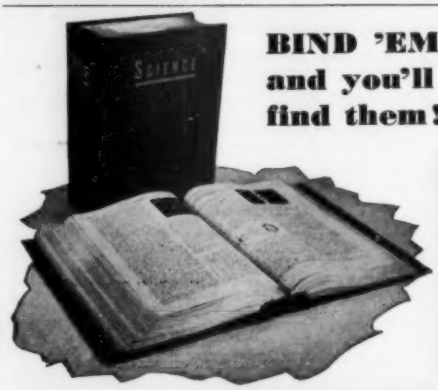
For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

SUPPLIES AND EQUIPMENT

3 NEW MICROSCOPE ILLUMINATORS by LINDLY
foremost in MICROSCOPE LAMPS

Brilliant, adjustable, variable intensity illumination *all-purpose* lamps for laboratory, research and industry.

LINDLY & CO. 80 HERRICKS RD. MINEOLA, N. Y.



BIND 'EM... and you'll find them!

Keep your copies of SCIENCE always available for quick, easy reference in this attractive, practical binder. Simply snap the magazine in or out in a few seconds—no punching or mutilating. It opens FLAT—for easy reference and readability. Sturdily constructed—holds 26 issues.

This beautiful maroon buckram binder stamped in gold leaf will make a fine addition to your library. Only $2.75 postpaid (personal check or money order please). Name, 70¢ extra—year of issue, 40¢ extra. ORDER YOURS NOW!

SCIENCE • 1515 Mass. Ave., N.W., Washington 5, D. C.

A STUDY of ANTIMETABOLITES

By D. W. WOOLLEY, *Rockefeller Institute for Medical Research.* This book offers a unified, critical study of a new field which shows great promise. The author has conducted many experiments with antimetabolites and has drawn upon this extensive experience in the preparation of this book. He attempts to give a good understanding of antimetabolites and emphasizes the correlation of existing knowledge in this field with established knowledge in other related fields of learning. *January 1952. 269 pages. Illus. $5.00.*

Dana's SYSTEM of MINERALOGY, Volume II

Halides, Nitrates, Borates, Carbonates, Sulfates, Phosphates, Arsenates, Tungstates, Molybdates, etc.

Seventh Edition Entirely Rewritten and Enlarged by CHARLES PALACHE, the late HARRY BERMAN, and CLIFFORD FRONDEL, all, *Harvard University.* This new edition of *Dana* follows the tradition of earlier ones —authoritative, detailed, and completely up-to-date. Added features include: a new mineral classification, based on crystal chemistry; an improved method of treating minerals which form a series, that is, describing a series as if it were a single-species description; and many more new features. *November 1951. 1124 pages. 499 illus. $15.00.*

THEORETICAL PETROLOGY

By TOM. F. W. BARTH, *Geological Museum at the University of Oslo.* Four sections—Physics and Chemistry of the Earth, Formation of Sedimentary Rocks, Igneous Rocks, and Metamorphic Rocks—provide a comprehensive, scientific study of the rock-making processes, interpreting and synthesizing all existing data. *1952. 387 pages. Illus. $6.50.*

The DESIGN and ANALYSIS of EXPERIMENTS

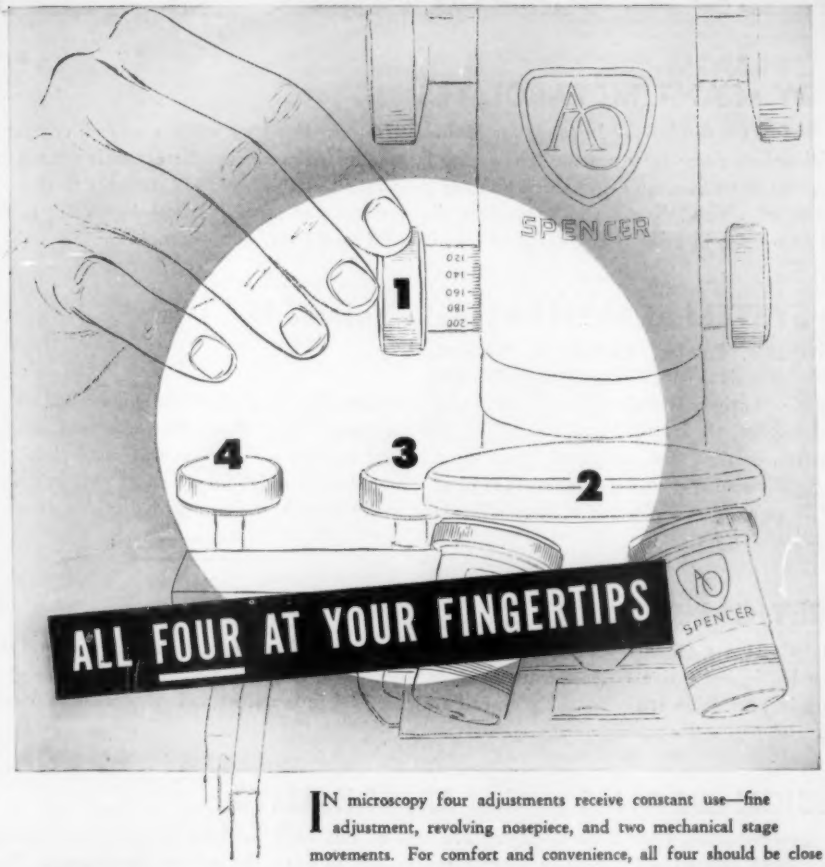
By OSCAR KEMPTHORNE, *Iowa State College.* "The aim of this book has been to give a description of the design of experiments from as broad a view as possible and to relate the subject matter of this field of statistics to the general theory of statistics and to the general problem of experimental inference." Techniques are explained and clarified for those with little mathematical training. A WILEY PUBLICATION IN STATISTICS, *Walter A. Shewhart, Editor. 1952. 631 pages. Illus. $8.50.*

TEXTBOOK of ORGANIC CHEMISTRY

Third Edition by GEORGE H. RICHTER, *The Rice Institute.* Since its first edition, this book has been set apart by its thorough treatment of fundamentals—nomenclature, theories, syntheses, and reactions. Changes include: new material on the electronic configuration of elements with special reference to sigma and pi bonds, nuclear structure, and isotopes of interest to organic chemistry; and other improvements reflecting recent progress. *1952. 762 pages. Illus. $6.75.*

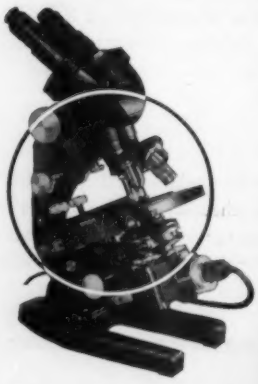
We'll be glad to send you on-approval copies of these books—write today.

JOHN WILEY & SONS, INC. 440 Fourth Avenue, New York 16



ALL FOUR AT YOUR FINGERTIPS

IN microscopy four adjustments receive constant use—fine adjustment, revolving nosepiece, and two mechanical stage movements. For comfort and convenience, all four should be close to one another and to the specimen. No matter at what angle you tilt an AO Spencer Laboratory Microscope, these adjustments are adjacent, visible, and so scientifically spaced that fingers glide automatically from one to the other. Even the coarse adjustment is aways right at hand.



You'll notice this typical AO *Design Perfection* also in the renowned Spencer Optics, dust-proof, dual-cone nosepiece, "pinch grip" mechanical stage, "autofocus", custom tension adjustment, built-in "full-field" illumination and many other features. But test the many AO Spencer advantages *yourself*. Ask your AO distributor for a demonstration or write Dept. A1.

American Optical
COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK